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ABSTRACT

The intent of this module is to engage students (grades 9-11) in an examination of issues that arise as a result of human activities in the physical environment. Activities are organized into two sections: the first focusing on weather modification and construction of dams as examples of planned environmental change and the second focusing on unplanned environmental changes (desertification, unintended weather modification, increases in atmospheric carbon dioxide, and erosion). To demonstrate socio-scientific conflicts, a simulation game, role-playing simulations, and dilemma/discussion formats are utilized to highlight and heighten the underlying issues. Dilemmas are brief stories posing a critical decision to be made by a main character. This decision revolves around conflicts between two or more moral/ethical issues (as identified by Kohlberg) presented in the situation, and it is the moral/ethical implication that provides the thrust for later student discussions. Preceding each dilemma are readings/case studies providing background information regarding issues in the dilemma. Questions and sample student responses (representing positions taken by typical students) are provided to stimulate thinking about the issues and generate discussions. The module may be used as a separate unit of study, mini-course, or incorporated in such subject areas as social studies, language arts, or science. (JN)

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PREPARING FOR TOMORROW'S WORLD

People and Environmental Changes

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Preparing for Tomorrow's World
An Interdisciplinary Curriculum Program

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Future Scenarios in Communications
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PREPARING FOR TOMORROW'S WORLD

People and Environmental Changes

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PREFACE

We live in an exciting, rapidly changing, and challenging world—a world highly dependent upon science and technology. Our world is changing so rapidly that we sometimes fail to recognize that much of what we today take for granted as common, everyday occurrences existed only in the imaginations of people just a few short years ago. Advances in science and technology have brought many dreams to fruition. Long before today's school children become senior citizens, much of today's "science fiction" will, in fact, become reality. Recall just a few accomplishments which not long ago were viewed as idle dreams:

- *New biomedical advances have made it possible to replace defective hearts, kidneys and other organs.*
- *The first air flight at Kitty Hawk lasted only a few seconds. Now, a little over half a century later space ships travel thousands of miles an hour to explore distant planets.*
- *Nuclear technology—of interest a few short years ago because of its destructive potential—could provide humankind with almost limitless supplies of energy for peace-time needs.*
- *Computer technology has made it possible to solve in seconds problems which only a decade ago would require many human lifetimes.*
- *Science and technology have brought us to the brink of controlling weather, earthquakes and other natural phenomena.*

Moreover, the changes which we have been experiencing and to which we have become accustomed are occurring at an increasingly rapid rate. Changes, most futurists forecast, will continue and, in fact, even accelerate as we move into the 21st Century and beyond. But, as Barry Commoner has stated, "There is no such thing as a free lunch." These great advances will not be achieved without a high price. We are now beginning to experience the adverse effects of our great achievements:

- *The world's natural resources are being rapidly depleted.*
- *Our planet's water and air are no longer pure and clean.*
- *Thousands of plant and animal species are threatened with extinction.*
- *Nearly half the world's population suffers from malnutrition.*

While science and technology have given us tremendous power, we are also confronted with an awesome responsibility: to use the power and ability wisely, to make equitable decision tradeoffs, and to make valid and just choices when there is no absolute "right" alternative. Whether we have used our new powers wisely is highly questionable.

Today's youth will soon become society's decision-makers. Will they be capable of improving upon the decision-making of the past? Will they possess the skills and abilities to make effective, equitable, long-range decisions to create a better world?

To the student:

This module has been prepared to help you—the student and future decision maker—function more effectively in a rapidly changing world. Other modules in the *Preparing for Tomorrow's World* program focus on additional issues of current and future importance.

To the teacher:

It is our belief that this module—and indeed the entire *Preparing for Tomorrow's World* program—will help you the teacher prepare the future decision-maker to deal effectively with issues and challenges at the interfaces of science/technology/society. It is our belief that the contents and activities in this program will begin to prepare today's youth to live life to the fullest, in balance with Earth's resources and environmental limits, and to meet the challenges of tomorrow's world.

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INTRODUCTION

"Man as an implement maker, the first and such on earth, has the power to transform landscapes and to manage soil and water resources so he has become, in effect, himself a major force of geological changes. When the first man or men began to fashion sticks, stones and bones to serve a given purpose, the metamorphosis began."

Russell Lord
The Care of the Earth: A Story of Husbandry

Through natural processes our planet Earth has undergone continuous change. Although the process is slow, Earth today is very different from Earth at its time of creation. The presence of people in the past several thousand years has brought about new varieties of changes. Applying science and fashioning tools, people have made major changes on Earth's surface and created new environments.

One needs only to take a quick look around to see how people have used Earth and its resources to adapt their surroundings to suit personal needs and activities. Cities, suburbs, highways are of course the most obvious evidences of man-made alterations of the landscape. While most people in the U.S. are not directly involved, on a daily basis, in farming and resource extraction they depend on those activities to sustain their lives and provide for their many comforts. These activities too are major change agents. Where once there were forests and swift running rivers there are now millions of acres of plowed fields, irrigation systems and electricity generating plants.

With the advent of modern science and technology people have acquired even more powerful tools to direct and control Earth's environment. Not only can people now change the surface, but they also can bring about changes deep into Earth's crust, such as drilling for water or oil, and far into the reaches of space, such as with supersonic jet flights and space exploration vehicles. In this module some of the ways in which people have modified the environment will be examined. It is true that each step one takes or each time one takes a breath of air one changes the surrounding ground and air. However, the types of modifications which we will be concerned with here are those with broader effects and, perhaps, less easily reversible or of a permanent nature. Many of the modifications are directed towards the attainment of specific goals such as those examined in Section I. Others are inadvertent or unintentional, that result from other activities as demonstrated in Section II. In both instances, nevertheless, the ways in which people seek to exert greater control over their environment or use Earth's resources often raises new problems and concerns. It is, therefore, necessary to question whether or not we have unwittingly opened "Pandora's Box" and unleashed a new set of difficult and undesirable problems. There may be no one simple answer to the question. By being alerted to some of the kinds of things we do and their many consequences, we may learn to act more wisely in the future.

Section I:

Planned Environmental Changes

ACTIVITY 1: THE RAINMAKERS

PART A: — Readings

From the time people became farmers and depended on large amounts of water for crops, the desire to control or influence the weather became all the more urgent. This is reflected in the rituals, rites, and ceremonies found among various peoples, designed to bring rain or divert dangerous storms. In some communities the rainmaker was frequently one of the more important or influential leaders. The following reading is excerpted from Chapter 5 of ***The Golden Bough*** *written by Sir James Frazer in 1922 and describes some of the rainmaking practices employed by people in various parts of the world at different times.*

Skim through these excerpts before meeting with members of your group.

Reading 1

The Magical Control Of Rain[1]

by Sir James Frazer

Of the things which the public magician sets himself to do for the good of the tribe, one of the chief is to control the weather and especially to ensure an adequate fall of rain. Water is an essential of life, and in most countries the supply of it depends upon showers. Without rain vegetation withers; animals and men languish and die. Hence in savage communities the rain-maker is a very important personage; and often a special class of magicians exists for the purpose of regulating the heavenly water-supply. The methods by which they attempt to discharge the duties of their office are commonly, though not always, based on the principle of homoeopathic or imitative magic. If they wish to make rain they simulate it by sprinkling water or mimicking clouds: if their object is to stop rain and cause drought, they avoid water and resort to warmth and fire for the sake of drying up the too abundant moisture. Such attempts are by no means confined, as the cultivated reader might imagine, to the naked inhabitants of those sultry lands like Central Australia and some parts of Eastern and Southern Africa, where often for months together the pitiless sun beats down out of a blue and cloudless sky on the parched and gaping earth. They are, or used to be, common enough among outwardly civilised folk in the moisture climate of Europe. I will now illustrate them by instances drawn from the practice both of public and private magic.

Thus, for example, in a village near Dorpat, in Russia, when rain was much wanted, three men used to climb up the fir-trees of an old sacred grove. One of them drummed with a hammer on a kettle or small cask to imitate thunder; the second knocked two fire-brands together and made the sparks fly, to imitate lightning; and the third, who was called "the rain-maker," had a bunch of twigs with which he sprinkled water from a vessel on all sides. To put an end to drought and bring down rain, women and girls of the village of Ploska are wont to go naked by night to the boundaries of the village and there pour water on the ground. In Halmahera, or Gilolo, a large island to the west of New

[1]This excerpted selection is from *The Golden Bough: A Study in Magic and Religion*, 1922. Reprinted by permission from MacMillan Publishing Co., Inc.

Guinea, a wizard makes rain by dipping a branch of a particular kind of tree in water and then scattering the moisture from the dripping bough over the ground. In New Britain the rain-maker wraps some leaves of a red and green striped creeper in a banana-leaf, moistens the bundle with water, and buries it in the ground; then he imitates with his mouth the plashing of rain. Amongst the Omaha Indians of North America, when the corn is withering for want of rain, the members of the sacred Buffalo Society fill a large vessel with water and dance four times round it. One of them drinks some of the water and spirts it into the air, making a fine spray in imitation of a mist or drizzling rain. Then he upsets the vessel, spilling the water on the ground; whereupon the dancers fall down and drink up the water, getting mud all over their faces. Lastly, they squirt the water into the air, making a fine mist. This saves the corn. In spring-time the Natchez of North America used to club together to purchase favourable weather for their crops from the wizards. If rain was needed, the wizards fasted and danced with pipes full of water in their mouths. The pipes were perforated like the nozzle of a watering-can, and through the holes the rain-maker blew the water towards that part of the sky where the clouds hung heaviest. But if fine weather was wanted, he mounted the roof of his hut, and with extended arms, blowing with all his might, he beckoned to the clouds to pass by. When the rains do not come in due season the people of Central Angoniland repair to what is called the rain-temple. Here they clear away the grass, and the leader pours beer into a pot which is buried in the ground, while he says, "Master *Chauta*, you have hardened your heart towards us, what would you have us do? We must perish indeed. Give your children the rains, there is the beer we have given you." Then they all partake of the beer that is left over, even the children being made to sip it. Next they take branches of trees and dance and sing for rain. When they return to the village they find a vessel of water set at the doorway by an old woman; so they dip their branches in it and wave them aloft, so as to scatter the drops. After that the rain is sure to come driving up in heavy clouds. In these practices we see a combination of religion with magic; for while the scattering of the water-drops by means of branches is a purely magical ceremony, the prayer for rain and the offering of beer are purely religious rites. In the Mara tribe of Northern Australia the rain-maker goes to a pool and sings over it his magic song. Then he takes some of the water in his hands, drinks it, and spits it out in various directions. After that he throws water all over himself, scatters it about, and returns quietly to the camp. Rain is supposed to follow. The Arab historian Makrizi describes a method of stopping rain which is said to have been resorted to by a tribe of nomads called Alqamar in Hadramaut. They cut a branch from a certain tree in the desert, set it on fire, and then sprinkled the burning brand with water. After that the vehemence of the rain abated, just as the water vanished when it fell on the glowing brand. Some of the Eastern Angamis of Manipur are said to perform a somewhat similar ceremony for the opposite purpose, in order, namely, to produce rain. The head of the village puts a burning brand on the grave of a man who had died of burns, and quenches the brand with water, while he prays that rain may fall. Here the putting out the fire with water, which is an imitation of rain, is reinforced by the influence of the dead man, who, having been burnt to death, will naturally be anxious for the descent of rain to cool his scorched body and assuage his pangs. . . .

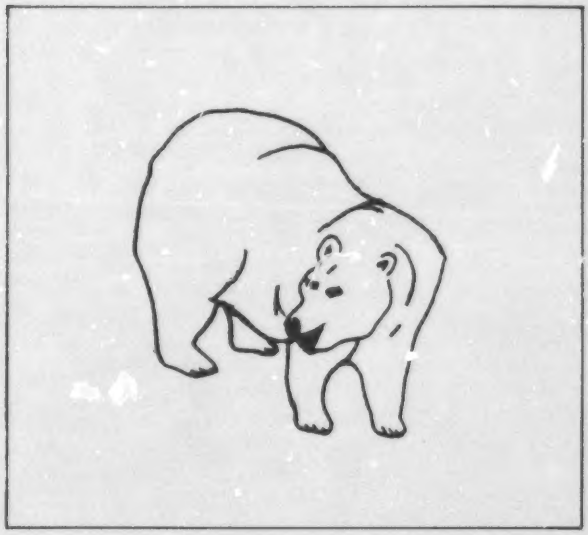
In the time of severe drought the Dieri of Central Australia, loudly lamenting the impoverished state of the country and their own half-starved condition, call upon the spirits of their remote predecessors, whom they call Mura-muras, to grant them power to make a heavy rainfall. For they believe that the clouds are bodies in which rain is generated by their own ceremonies or those of neighbouring tribes, through the influence of the Mura-muras. The way in which they set about drawing rain from the clouds is this. A hole is dug about twelve feet long and eight or ten broad, and over this hole a conical hut of logs and branches is made. Two wizards, supposed to have received a special inspiration from the Mura-muras, are bled by an old and influential man with a sharp flint; and the blood, drawn from their arms below the elbow, is made to flow on the other men of the tribe, who sit huddled together in the hut. At the same time the two bleeding men throw handfuls of down about, some of which adheres to the blood-stained bodies of their comrades, while the rest floats in the air. The blood is thought to represent the rain, and the down the clouds. During the ceremony two large stones are placed in the middle of the hut; they stand for gathering clouds and presage rain. Then the wizards who were bled carry away the two stones for about ten or fifteen miles, and place them as high as they can in the tallest tree. Meanwhile the other men gather gypsum, pound it fine, and throw it into a water-hole. this the Mura-muras see, and at once they cause clouds to appear in the sky. Lastly, the men, young and old, surround the hut, and stooping down, butt at it with their heads, like so many rams. Thus they force their way through it and reappear on the other side, repeating the process till the hut is wrecked. In doing this they

An Indian Rainmaker

are forbidden to use their hands or arms; but when the heavy logs alone remain, they are allowed to pull them out with their hands. "The piercing of the hut with their heads symbolises the piercing of the clouds; the fall of the hut, the fall of the rain." Obviously, too, the act of placing high up in trees the two stones, which stand for clouds, is a way of making the real clouds to mount up in the sky. . . .

After the rains have fallen, some of the tribe always undergo a surgical operation, which consists in cutting the skin of their chest and arms with a sharp flint. The wound is then tapped with a flat stick to increase the flow of blood, and red ochre is rubbed into it. Raised scars are thus produced. The reason alleged by the natives for this practice is that they are pleased with the rain, and that there is a connexion between the rain and the scars. Apparently the operation is not very painful, for the patient laughs and jokes while it is going on. Indeed, little children have been seen to crowd round the operator and patiently take their turn; then after being operated on, they ran away, expanding their little chests and singing for the rain to beat upon them. However, they were not so well pleased next day, when they felt their wounds stiff and sore. In Java, when rain is wanted, two men will sometimes thrash each other with supple rods till the blood flows down their backs; the streaming blood represents the rain, and no doubt is supposed to make it fall on the ground. The people of Egghiou, a district of Abyssinia, used to engage in sanguinary conflicts with each other, village against village, for a week together every January for the purpose of procuring rain. Some years ago the emperor Menelik forbade the custom. However, the following year the rain was deficient, and the popular outcry so great that the emperor yielded to it, and allowed the murderous fights to be resumed, but for two days a year only. The writer who mentions the custom regards the blood shed on these occasions as a propitiatory sacrifice offered to spirits who control the showers; but perhaps, as in the Australian and Javanese ceremonies, it is an imitation of rain. The prophets of Baal, who sought to procure rain by cutting themselves with knives till the blood gushed out, may have acted on the same principle.

There is a widespread belief that twin children possess magical powers over nature, especially over rain and the weather. This curious superstition prevails among some of the Indian tribes of British Columbia, and has led them often to impose certain singular restrictions or taboos on the parents of twins, though the exact meaning of these restrictions is generally obscure. Thus the Tsimshian Indians of British Columbia believe that twins control the weather; therefore they pray to wind and rain, "Calm down, breath of the twins." Further, they think that the wishes of twins are always fulfilled; hence twins are feared, because they can harm the man they hate. They can also call the salmon and the olachen or candle-fish, and so they are known by a name which means "making plentiful." In the opinion of the Kwakiutl Indians of British Columbia twins are transformed salmon; hence they may not go near water, lest they should be changed back again into the fish. In their childhood they can summon any wind by motions of their hands, and they can make fair or foul weather, and also cure diseases by swinging a large



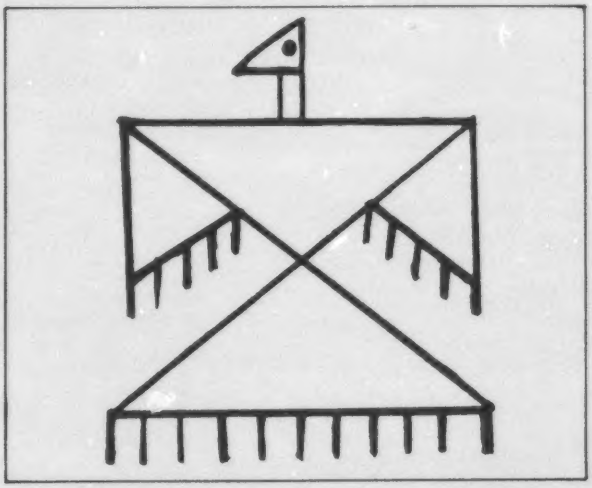
The Grizzly Bear, Magical Rainmaking Power. . ?

wooden rattle. The Nootka Indians of British Columbia also believe that twins are somehow related to salmon. Hence among them twins may not catch salmon, and they may not eat or even handle the fresh fish. They can make fair or foul weather, and can cause rain to fall by painting their faces black and then washing them, which may represent the rain dripping from the dark clouds. The Shuswap Indians, like the Thompson Indians, associate twins with the grizzly bear, for they call them "young grizzly bears." According to them, twins remain throughout life endowed with supernatural powers. In particular they can make good or bad weather. They produce rain by spilling water from a basket in the air; they make fine weather by shaking a small flat piece of wood attached to a stick by a string; they raise storms by strewing down on the ends of spruce branches. . . .

It is interesting to observe that where an opposite result is desired, primitive logic enjoins the weather-doctor to observe precisely opposite rules of conduct. In the tropical island of Java, where the rich vegetation attests the abundance of the rainfall, ceremonies for the making of rain are rare, but ceremonies for the prevention of it are not uncommon. When a man is about to give a great feast in the rainy season and has invited many people, he goes to a weather-doctor and asks him to "prop up the clouds that may be lowering." If the doctor consents to exert his professional powers, he begins to regulate his behaviour by certain rules as soon as his customer has departed. He must observe a fast, and may neither drink nor bathe; what little he eats must be eaten dry, and in no case may he touch water. The host, on his side, and his servants, both male and female, must neither wash clothes nor bathe so long as the feast lasts, and they have all during its continuance to observe strict chastity. The doctor seats himself on a new mat in his bedroom, and before a small oil-lamp he murmurs, shortly before the feast takes place, the following prayer or incantation: "Grandfather and Grandmother Sroekoel" (the name seems to be taken at random; others are sometimes used), "return to your

country. Akkemat is your country. Put down your water-cask, close it properly, that not a drop may fall out." While he utters this prayer the sorcerer looks upwards, burning incense the while. So among the Toradjas the rain-doctor, whose special business it is to drive away rain, takes care not to touch water before, during, or after the discharge of his professional duties. He does not bathe, he eats with unwashed hands, he drinks nothing but palm wine, and if he has to cross a stream he is careful not to step in the water. Having thus prepared himself for his task he has a small hut built for himself outside of the village in a rice-field, and in this hut he keeps up a little fire, which on no account may be suffered to go out. In the fire he burns various kinds of wood, which are supposed to possess the property of driving off rain; and he puffs in the direction from which the rain threatens to come, holding in his hand a packet of leaves and bark which derive a similar cloud-compelling virtue, not from their chemical composition, but from their names, which happen to signify something dry or volatile. If clouds should appear in the sky while he is at work, he takes lime in the hollow of his hand and blows it towards them. The lime, being so very dry, is obviously well adapted to disperse the damp clouds. Should rain afterwards be wanted, he has only to pour water on his fire, and immediately the rain will descend in sheets.

The reader will observe how exactly the Javanese and Toradja observances, which are intended to prevent rain, form the antithesis of the Indian observances, which aim at producing it. The Indian sage is commanded to touch water thrice a day regularly as well as on various special occasions; the Javanese and Toradja wizards may not touch it at all. The Indian lives out in the forest, and even when it rains he may not take shelter; the Javanese and the Toradja sit in a house or a hut. The one signifies his sympathy with water by receiving the rain on his person and speaking of it respectfully; the others light a lamp or a fire and do their best to drive the rain away. Yet the principle on which all three act is the same; each of them, by a sort or childish make-believe, identifies himself with the phenomenon which he desires to produce. It is the old fallacy that the effect resembles its cause: if you would make wet weather, you must be wet; if you would make dry weather, you must be dry. . . .



To Some, Birds Have Magical Powers

Animals, again, often play an important part in these weather-charms. The Anula tribe of Northern Australia associate the dollar-bird with rain, and call it the rain-bird. A man who has the bird for his totem can make rain at a certain pool. He catches a snake, puts it alive into the pool, and after holding it under water for a time takes it out, kills it, and lays it down by the side of the creek. Then he makes an arched bundle of grass stalks in imitation of a rainbow, and sets it up over the snake. After that all he does is to sing over the snake and the mimic rainbow; sooner or later the rain will fall. They explain this procedure by saying that long ago the dollar-bird had as a mate at this spot a snake, who lived in the pool and used to make rain by spitting up into the sky till a rainbow and clouds appeared and rain fell. A common way of making rain in many parts of Java is to bathe a cat or two cats, a male and a female; sometimes the animals are carried in procession with music. Even in Batavia you may from time to time see children going about with a cat for this purpose; when they have ducked it in a pool, they let it go. . . .

Sometimes, when a drought has lasted a long time, people drop the usual hocus-pocus of imitative magic altogether, and being far too angry to waste their breath in prayer they seek by threats and curses or even downright physical force to extort the waters of heaven from the supernatural being who has, so to say, cut them off at the main. In a Japanese village, when the guardian divinity had long been deaf to the peasants' prayers for rain, they at last threw down his image and, with curses loud and long, hurled it head foremost into a stinking rice-field. "There," they said, "you may stay yourself for a while, to see how *you* will feel after a few days' scorching in this broiling sun that is burning the life from our cracking fields." In the like circumstances the Feloupes of Senegambia cast down their fetishes and drag them about the fields, cursing them till rain falls.

The Chinese are adept in the art of taking the kingdom of heaven by storm. Thus, when rain is wanted they make a huge dragon of paper or wood to represent the rain-god, and carry it about in procession; but if no rain follows, the mock-dragon is execrated and torn to pieces. At other times they threaten and beat the god if he does not give rain; sometimes they publicly depose him from the rank of deity. On the other hand, if the wished-for rain falls, the god is promoted to a higher rank by an imperial decree. In April 1888 the mandarins of Canton prayed to the god Lung-wong to stop the incessant downpour of rain; and when he turned a deaf ear to their petitions they put him in a lock-up for five days. This had a salutary effect. The rain ceased and the god was restored to liberty. Some years before, in time of drought, the same deity had been chained and exposed to the sun for days in the courtyard of his temple in order that he might feel for himself the urgent need of rain. So when the Siamese need rain, they set out their idols in the blazing sun; but if they want dry weather, they unroof the temples and let the rain pour down on the idols. They think that the inconvenience to

which the gods are thus subjected will induce them to grant the wishes of their worshippers.

The reader may smile at the meterology of the Far East; but precisely similar modes of procuring rain have been resorted to in Christian Europe within our own lifetime. By the end of April 1893 there was great distress in Sicily for lack of water. The drought had lasted six months. Every day the sun rose and set in a sky of cloudless blue. The gardens of the Conca d'Oro, which surround Palermo with a magnificent belt of verdure, were withering. Food was becoming scarce. The people were in great alarm. All the most approved methods of procuring rain had been tried without effect. Processions had traversed the streets and the fields. Men, women, and children, selling their beads, had lain whole nights before the holy images. Consecrated candles had burned day and night in the churches. Palm branches, blessed on Palm Sunday, had been hung on the trees. At Solaparuta, in accordance with a very old custom, the dust swept from the churches on Palm Sunday had been spread on the fields. In ordinary years these holy sweepings preserve the crops; but that year, if you will believe me, they had no effect whatever. At Nicosia the inhabitants, bare-headed and bare-foot, carried the crucifixes through all the wards of the town and scourged each other with iron whips. It was all in vain. Even the great St. Francis of Paolo himself, who annually performs the miracle of rain and is carried every spring through the market-gardens, either could not or would not help. Masses, vespers, concerts, illuminations, fire-works — nothing could move him. At last the peasants began to lose patience. Most of the saints were banished. At Palermo they dumped St. Joseph in a garden to see the state of things for himself, and they swore to leave him there in the sun till rain fell. Other saints were turned, like naughty children, with their faces to the wall. Others again, stripped of their beautiful robes, were exiled far from their parishes, threatened, grossly insulted, ducked in horse-ponds. At Caltanisetta the golden wings of St. Michael the Archangel were torn from his shoulders and replaced with wings of pasteboard; his purple mantle was taken away and a cloud wrapt about him instead. At Licata the patron saint, St. Angelo, fared even worse, for he was left without any garments at all; he was reviled, he was put in irons, he was threatened with drowning or hanging. "Rain or the rope!" roared the angry people at him, as they shook their fists in his face.

Sometimes an appeal is made to the pity of the gods. When their corn is being burnt up by the sun, the Zulus look out for a "heaven bird," kill it, and throw it into a pool. Then the heaven melts with tenderness for the death of the bird; "it wails for it by raining, wailing a funeral wail." In Zululand women sometimes bury their children up to the neck in the ground, and then retiring to a distance keep up a dismal howl for a long time. The sky is supposed to melt with pity at the sight. Then the women dig the children out and feel sure that rain will soon follow. They say that they call to "the lord above" and ask him to send rain. If it comes they declare that "Usondo rains." In times of drought the Guanches of Teneriffe led their sheep to sacred ground, and there they separated the lambs from their dams, that their plaintive bleating might touch the heart of the god. In Kumaon a way of stopping rain is to pour hot oil in the left ear of a dog. The animal howls with pain, his howls are heard in Indra, and out of pity for the beast's sufferings the god stops the rain. Sometimes the Toradjas attempt to procure rain as follows. They place the stalks of certain plants in water, saying, "Go and ask for rain, and so long as no rain falls I will not plant you again, but there shall you die.' Also they string some fresh-water snails on a cord, and hang the cord on a tree, and say to the snails, "Go and ask for rain, and so long as no rain comes, I will not take you back to the water." Then the snails go and weep, and the gods take pity and send rain. However, the foregoing ceremonies are religious rather than magical, since they involve an appeal to the compassion of higher powers.

An American Indian Dancer Tries To Make It Rain

PART B — Rainmaking Ceremonies

Early Rainmaking Ceremonies:

Small groups of 3 to 4 students will work together to complete this activity.

Select from the reading one of the rain ceremonies/rituals for further discussion and respond to the following questions.

- What type of ceremony or ritual was performed? An offering or good works? A magical charm? A communication to supernatural forces?
- Can you determine how the people felt towards natural forces or the controller of weather? Fear? Acceptance? Anger?
- What/who to these people was the maker of rainstorms? Magic? Gods? What was their role in rainmaking?
- Did they believe that nature resembles humans? Did nature have a personality? How can you tell?
- What was their view of people's relationship to nature? People should try to control nature? People should accept nature? People can change nature? Does nature work for people or do people work with nature?
- Who might be blamed if the rain did not come?
- In some cases the ritual was an imitation of rainfall. What types of symbols were used in the imitation?

Organize your thoughts and ideas in a short summary that describes how the people felt about the forces of nature and what they believed brought about weather changes.

Meet with another group and present your summary. They, in turn, will present their summary to you.

A Scientific Explanation of Rain:

Return to your original group to plan your next presentation. Your task is to imagine that the group you just met with represents the people they described. Using your knowledge about rainfall, you are to develop a scientific explanation of rainfall. In developing your explanation consider the following:

- What is the other group's belief about weather?
- What is the basis for their belief? How can you convince them that their belief is erroneous?
- In what way can you show them that your ideas are correct. What is your proof?
- How can you best describe this to them? Drawings? Diagrams? Experiment?
- Do additional research or readings if necessary to help you in your explanation of weather and rainfall.

At the next meeting with the other group, present your explanation.

- Are they willing to accept your explanation? If not, why?
- What arguments do they give to support the ideas they hold?

Your group will in turn hear the explanation given by the other group.

- At this time you must try to put yourself in the position of the people you represent. Remember, you hold your beliefs strongly and it is difficult to change your ideas. In what way can you defend your belief? Are the arguments convincing?

After the two explanations are given and the arguments discussed, each person will privately vote on whether he/she, as a person in the earlier culture, will accept the scientific evidence presented. Indicate this as "yes" or "no" on a separate piece of paper and turn it over to the student who will count the votes.

- What are the results?
- Why might the evidence be accepted or rejected?
- In what way might the new knowledge help or hinder the people? Will it change the way they lived and acted?
- Is there a way to prove that the rituals and ceremonies did not "make" rain?
- Do people today use any of these techniques to call for rain?

Activity 2: Controlling The Rain

PART A — Readings

Controlling The Rains Could Have Prevented Flooding

Reading 2

"Rainmaking In The Modern Age"

Our scientific rainmaking techniques today can be traced back to the 1940's and the dry-ice experiments of Vincent Schaefer, and the theories of Nobel prize winner, Dr. Irving Langmuir. The problem they had to solve was to make water droplets in the clouds large and heavy so that moisture will fall to the ground instead of remain suspended as clouds. They found by super cooling the water vapor of clouds with dry ice, ice crystals would form and fall as snow or rain depending upon the surrounding temperature. The first cloud seeding flights took place in December of 1946 and dramatically showed that where dry ice was dropped snow formed, leaving large clear areas in the clouds.

Shortly afterwards, Dr. Bernard Vonnegut discovered that ice crystals can be produced by introducing artificial ice shaped particles onto which water vapor will collect and form larger crystals or droplets. The crystals were silver iodide. One advantage to using silver iodide was that one could produce silver iodide "smoke" on the ground and allow air currents to carry it up to the clouds. It was not necessary then to drop the particles from airplanes onto the cloud; one could simply control everything from the ground.

Cloud seeding to produce rain has significant benefits in many areas. With increased rainfall wheat farmers in normally drier regions can produce larger harvests. Airports can clear their airstrips of fog and insure safer landings through improved visibility. Drought prone areas can increase their water supply for drinking and irrigation. Ski resort operators can keep their slopes well packed with snow and perhaps extend their operating season. Increased water supplies can increase the electricity generating capacity of hydroelectric generators.

Cloud seeding can also serve to avert catastrophes. Hail just before harvest time is disastrous to farmers but can be suppressed by over-seeding the clouds. Millions of dollars of crop damage can thus be avoided. The force of hurricanes if dissipated by seeding further out at sea can drastically reduce damage to property and protect lives in densely populated coastal areas.

State and local governments and private operators were soon in the rainmaking business. By 1959 thirty-six weather modification projects were in operation. In 1973 cloud seeding to produce snow and rain or to reduce the amount of hail involved over 135,000 square miles or 5% of U.S. land area.

Reading 3

Making Weather Fit The Crops

Mark Twain's observation — that everybody talks about the weather, but no one ever does anything about it — may soon become outdated. Scientists already have the know-how to modify weather in order to stabilize food production, and within a few years, the technology may be applied on a large-scale basis.

Weather control may be coming just in time, according to scientists writing in the recently-published *McGraw-Hill Encyclopedia of Food, Agriculture, and Nutrition*. Meteorologist James D. McQuigg, for instance, warns that many projections of agricultural yields and grain production for the coming decades are based on data collected over the past two decades — a time during which the world may have experienced unusually good weather. Projections based on this period assume that world climate will remain as good as it has been recently. But McQuigg believes that the world's luck may change for the worse. If climate returns to the cooler temperatures experienced between 1600 and 1850, food expert Douglas Ross says, one quarter of India's population would starve, the Soviet Union would lose a major portion of its arable land, and Canadian export capacity would decline by 75%.

Also worrying scientists is the decreasing ability of crops to adjust to different weather conditions. Biologist H. Garrison Wilkes reports that fewer kinds of plants are being grown to feed the world, and the variation in each species of food plant is also diminishing, thus further reducing the chances to breed new varieties that can adapt to local weather conditions. A mere 15 plants now provide three-fourths of the food calories consumed by humanity.

To make the weather more dependable, major weather modification developments will take place within the next few years, according to a recent National Research Council report on *Climate and Food*. The report indicates that prospects are favorable for successful weather modification in the years ahead. Specifically:

- **Increasing rain.** Seeding mountain-created clouds with silver iodide offers the best bet. Under some conditions, research within the next few years

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may bring successful seeding of summer and tropical storm clouds.

- **Suppressing hail.** Crop losses from hail in the United States alone amount to about 1% of the annual crop value, or as much as $1 billion. Wheat, corn, and soybeans — three of the most important American crops — suffer the most. More than one-fourth of the U.S. wheat crop is lost to hail each year. Recent field experiments suggest that hail might be suppressed as much as 30% by artificial means. The most promising approach is to seed hail-causing clouds so as to reduce the size of hail particles.

- **Local temperature control.** In the future, scientists will be able to form clouds at will in order to shade unusually hot areas. Scientists are already able to create high-altitude cirrus clouds by seeding the skies during conditions of high humidity but no clouds. Scientists are also seeking ways to clear away clouds to allow sunlight to reach crops that need short periods of direct sunlight. (Cherries, apples and some vegetable crops would benefit the most.) By modifying clouds in the early stages of development, the skies could be cleared, and damaging winds reduced.

In areas with high cloud-seeding potential, precipitation can be increased by 70% to 80%. In most areas, continuous weather modification during periods of both favorable and unfavorable seeding conditions could increase rain an average of 10% to 20%. Such an improvement might not seem important, but the researchers report that a mere 10% increase in rain where needed would add 38 million bushels of corn, 34 million bushels of wheat, and 18.5 million bushels of soybeans to annual American production of grain. Reducing hail by the 30% considered feasible would increase production even more, almost doubling the added wheat crop alone. Weather modification techniques now in use cost only 15 to 50 cents per acre. As the techniques become more sophisticated, the cost may rise considerably. But even inflated prices would add up to only 2% to 3% of money now lost to the weather. And most of the equipment needed for weather modification — aircraft, radar, minicomputers, etc. — can be adapted to other farm uses.

Another benefit of weather modification is to make farming more predictable. Present crop variability forces dealers to store grain during good years and distribute it during the bad years. Storing grain is expensive; current annual storage costs equal about one-seventh the value of the grain itself. When food prices go up during bad seasons, the nations that need food the most often do not have the capital to buy the stored grain. Weather modification would increase productivity — and allow farmers to plan how much food to produce.

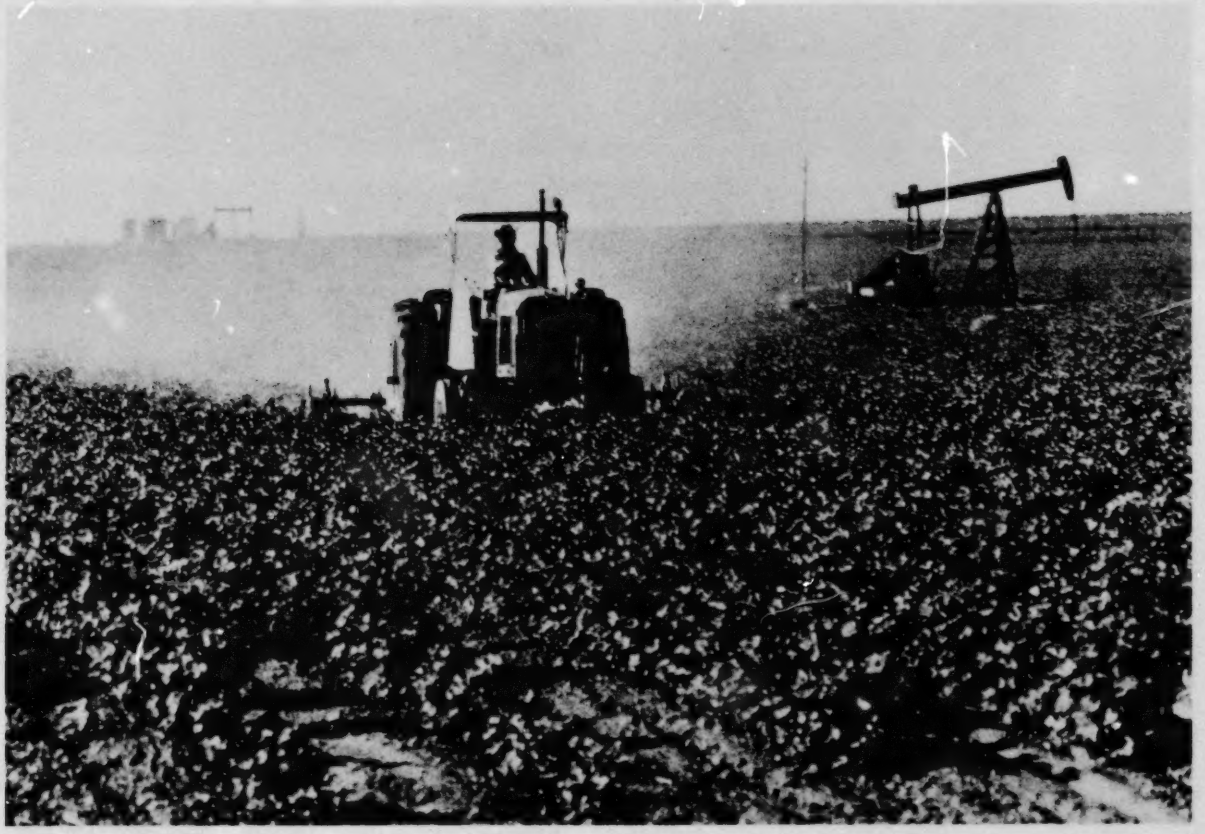
One of the biggest obstacles to the application of weather modification techniques is not the know-how, but fears concerning unintended consequences. Areas only miles apart often have radically different weather patterns. Weather modification geared toward one locality might have disastrous consequences on a neighboring region. Even individual cloud systems are complex, and contain huge energy transactions — a single storm cloud can release the energy of several atomic bombs. Governments and concerned groups are increasingly expressing doubts over the safety of modification. The National Research Council reports that a hail-suppression project undertaken by a group in southern Colorado was halted by farmers who feared that rainfall would be reduced along with the hail. Thirty states have adopted weather modification control laws, and the federal government requires that all activities be reported. As weather modification becomes widespread, international conflicts will arise over its use. Nonetheless, NRC scientists claim that weather modification over homogeneous areas of land does not seem to cause many harmful effects.

Man is already modifying the weather on a massive scale, albeit unintentionally. Scientists report that industrial activity has increased the frequency of thunderstorms east of St. Louis by 20% to 30%; hailstorms have increased 100%. Jet trails cause "false cirrus" clouds of ice particles that may keep the sun's rays from warming the earth. Other kinds of pollution — dust from soil erosion and carbon dioxide released from factories — may be warming and cooling the earth simultaneously. Climatologist Stephen Schneider suggests that a warming trend caused by industrial pollution may produce drier weather in the U.S. central plains while increasing tropical monsoon rains in the already-wet regions of the world. Weather modification would be needed just to restore the status quo.

Scientists predict that weather modification will become common within the next several years. It will take a great deal more research before the local weatherman will be able to announce rather than predict the weather. But the increasing sophistication of modification techniques is making such an occurrence more likely.

REVIEW QUESTIONS

- What is the scientific principle used in cloud seeding?
- Why is there so much interest in weather modification?
- In what ways can we benefit from changing the weather?
- What types of problems can result from weather modification activities?
- Can weather modification activities create conflict between countries? Is it possible to use weather modification as a weapon?
- Have you ever wanted to change the weather? How did you want it changed?



Water Is Key To A Successful Harvest

PART B — "You Are the Judge — A Decision Making Game"

Object Of The Game:

Five court cases are presented, each with four possible decision choices. Players will form teams to select the decision they believe was the one made by the court. Points are awarded for selecting the *Court's Decision* or a *Fair Decision*. The team with the highest score is declared the winner.

Game Procedure

- Players will form into teams of 3-5 members.
- Each team will discuss the five cases one at a time. It will then select from the four possible choices the decision it believes was reached by the court and the reason for that decision.
- 15 minutes are allotted for the discussion of *each case* and selection of the decision. The players must reach an unanimous agreement. Each team will then write a short statement stating why it made that particular choice. (i.e., Give your reason(s) for selecting the decision and explain why you think it is the best choice.)
- At the end of 15 minutes the game moderator will ask each team to state its decision and read the statement explaining why that selection was made. A representative from each team is selected to make the report. For each case, a different team spokesman should make the presentation. The results and explanations will be recorded on the blackboard.

TEAM NUMBER	DECISION NUMBER	REASON
1.		
2.		
3.		
4.		
5.		
6.		

- **Challenging the Decision:** A team may decide that none of the choices are adequate. The team may then develop its own decision and reasons for that decision. It will also provide an explanation for why that decision is better than the choices given. This *New Decision* will be presented at the team's turn to announce

its choice. The other players will then vote to determine if this decision and reasons for the decision are acceptable. If this new decision receives a majority of the votes the decision will be awarded a 4-point score. (New Decision) If it receives less than 50% of the votes but more than 25%, 2 points are awarded. No point is given if less than 25% of the other players vote in its favor.

- When all results and explanations are recorded, the individual teams may have 5 minutes to review the explanation and decide whether or not it wishes to change its choice. If a change is made, the team will receive one point less than the points assigned that choice. (e.g., The score for selecting the court's decision is 4. If the team switches from its initial choice to that choice it will receive 3 points.)

- The moderator will record the team's score for that case, using a table similar to the one below.

Scoring

- After all the selections have been announced and recorded, the moderator will read from the teacher's guide the *Court's Decision* and the score for each of the other choices.

- Points are awarded as follows:

	Points
COURT'S DECISION	4
FAIR DECISION	2
POOR DECISION	0
NEW DECISION	4 — > 50% of votes
	2 — 25 - 50% of votes
	0 — < 25% of votes

(Reminder: A decision that has been changed receives one less point.)

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	TOTAL
Team 1						
Team 2						
Team 3						
Team 4						
Team 5						
Team 6						

The remaining cases will be discussed and scored in the same manner. After completing the five cases, the scores are totalled and the winning team declared.

CASE ONE

The Center City Flood

Center City experienced its worse storm in history on December 1955, and the damages were devastating. The levees above the town gave way. Flood waters poured in killing 37 persons, injuring over 3,000, destroying 450 homes and damaging 6,000 more. Losses ran into the hundred of millions.

Who was to blame and how could damages be recovered? Was it the fault of town officials who failed to evacuate the town? Were the levees not properly maintained by the country?

Investigating all possible causes for the disaster the town officials learned that the state's largest electric company had been operating rainmaking equipment in 10 sites around the area. The purpose was to increase the snowpack in the mountains and thereby increase the water supply to run its electricity generators. The town officials put two and two together and concluded that rainmaking had increased the normal amount of rainfall. The added rain filled the river to capacity, soaked the soil and weakened the levee system.

The town then filed action against the electric company, contending that it was liable for the losses suffered by the Center City residents.

Mr. Marks, lawyer for the electric company, questioned the company representatives.

Mr. Marks: *How long have you been cloud seeding in the area and what were the results?*

Company Representative: *For two years. But most of the rain and snowpack we made runs into Lake Thoms. We increased rain in our target area by 26%. Nonetheless, Lake Thoms has never spilled over.*

Mr. Marks: *Did you seed prior to the storm, and did you seed those particular storm clouds?*

Company Representative: *Yes, we seeded the first part of the week but turned off the generators the day before the storm because the clouds were too high to be reached with our ground generators.*

Mr. Marks: *Did you have approval to conduct the cloud seeding?*

Company Representative: *Yes, we were granted permission by the state, and the cloud seeding company has a state license to operate.*

Mr. Nils, lawyer for the town, questioned Mr. Moore, a weather expert.

Mr. Nils: *What were the weather conditions just before the storm?*

Mr. Moore: *Snow and rainfall for the first half of the month broke all previous records, but high temperatures in the mountains melted 30 inches of snow in three days.*

Mr. Nils: *Could the silver iodide, generated the day before, have reached the storm clouds?*

Mr. Moore: *That is a possibility but most would have increased rainfall over the area which drains into Lake Thoms, 50 miles away.*

How did the court decide? What reasons did it give for that decision?

A. Yes, the company is liable because it should not be tampering with the weather.

B. No, the company is not liable because that storm was an act of God.

C. Yes, the company is liable because the area never had so much rainfall.

D. No, the company is not liable because there is lack of proof that seeding had a direct effect on the disasterous storm.

CASE TWO

Robbing Peter to Pay Paul
(or Who Has the Right to the Clouds Above?)

Paul, a wheat farmer in Texas, joined with neighboring wheat farmers to hire the firm, Weather Changers, to conduct hail suppressing operations during the farming season. The year before, severe hail storms had damaged their crops so badly that they lost over half the harvest. The farmers felt that they could not take such a chance again. Another bad year and they might all be out of business.

For a year, cloud seeding operations were conducted over the entire area. The number of hail storms were reduced, and the farmers enjoyed a good wheat harvest. Peter, a neighboring rancher to the northeast, however, was left with dry and sparse grass that year. He was forced to spend several thousand dollars to buy grain to feed his cattle. He felt that the cloud seeding had robbed him of the normal rainfall necessary to keep his grasses green and animals fed.

Peter went to court to ask that it issue a ban on all future cloud seeding activities in the area.

How did the court decide? What reasons did it give for that decision?

A. The farmers *may continue* to seed clouds because there is no law stating that they cannot.

B. The farmers *must stop* seeding because the ranchers have a right to the rainfall Nature provides over their land.

C. The farmers *may continue* to seed because they have a right to protect their crops.

D. The farmers *must stop* seeding because they are causing harm to the ranchers.

CASE THREE

Filling the City Reservoir

City X, the largest city on the East Coast with over 10 million people, was suffering a severe water shortage. There had been no winter snow, and spring rains were sparse that year. Pure drinking water from its mountain reservoir had reached a critically low point. The City hired Dr. Hone to seed the clouds as they passed by the mountains in order to raise the water level of the reservoir. After the seeding operations, the reservoir gained a two-week supply of water.

This brought immediate relief to the city residents, but Mr. Sax was most displeased. He owned a large fancy resort in the mountains, and because of the rains his resort was deserted. Each day of rain caused him to lose thousands of dollars. His business depended on good summer weather.

Mr. Sax went to court to ask that the seeding operations be ordered stopped. He pointed out that the unexpected summer rains harmed his resort business. In addition, the increased amounts of rain might overflow the mountain streams, causing possible property damage to people living along the stream.

How did the court decide? What reasons did it give for that decision?

A. City X *may* continue to seed clouds because water is important to the welfare of the general public.

B. City X *may not* continue to seed clouds because it does not have a right to disturb clouds over someone else's property.

C. City X *may* continue to seed clouds because there is no evidence that the rains will cause flooding. (speculative nature of risk)

D. City X *may not* continue to seed clouds because it will be taking rain away from other areas.

CASE FOUR

Not Enough Rain

Tom Hayes was assured by Rainfall Inc. that cloud seeding would solve all his worries over the drought forecasted for that year. He paid the company $5,000 to seed clouds over his farm for the season and then went ahead and planted all his wheat fields.

Whenever the clouds passed by, company planes flew over and seeded. Sometimes rain fell and other times it did not. By the middle of summer, the wheat was wilting from the heat and lack of water.

Tom was furious. This was not what he expected. Now his huge investment of seed, fertilizer and extra hired help was "going down the drain"! How was he to recover such a great loss?

He felt that Rainfall Inc. had led him astray with their promise. He went to court to demand a refund on the payment as well as money to compensate for his crop loss.

In court, Rainfall Inc. argued that it did not promise with absolute certainty that Tom would reap an abundant harvest. It did not sign an agreement to deliver so many gallons of water. "Anyway," said the company representative, "controlling weather is tricky business; you cannot always predict that all clouds will behave in the same way. Under some conditions no matter what you do, rain cannot be produced. It is like trying to wring water out of a dry sponge."

Tom's lawyer, on the other hand, contended that the company had misrepresented itself by making claims that it could avert the drought. Tom trusted its judgment and therefore went ahead with his plans.

How did the court decide? What reasons did it give for that decision?

A. Rainfall Inc. *must* return the money because it didn't know what it is doing and shouldn't be in the business.

B. Rainfall Inc. *need not* return the money because it performed the services agreed upon.

C. Rainfall Inc. *must* return the money because it claimed that cloud seeding would solve the problem of insufficient rainfall.

D. Rainfall Inc. *need not* return the money because there is not enough proof that it was trying to cheat Tom.

CASE FIVE

Scientific Uncertainty

"Cloud seeding is still an experiment," reported Dr. Bruce, "and more experiments are needed before we can say with certainty how much we truly benefit from cloud seeding. Will cloud seeding benefit one area to the detriment of another? I recommend that we conduct experiments over a larger area and for a longer time period. In this way we can begin to learn more about the behavior of different types of clouds and how different seeding materials might affect the outcome of a storm."

In response to Dr. Bruce's report, three adjoining states organized a hail suppression program. In the study they would compare crop production in areas where hail storms are seeded to areas where this is not done. They would also study different cloud seeding methods and materials and gather information about different cloud types and on how to select clouds for seeding. A tri-state weather study committee was formed to select the areas for the test and those areas to be left as control and to design the procedures to be used.

A year after the program began, a survey of the crop harvest in the seeded areas showed a 25% reduction in crop loss. This certainly pleased the farmers in the area. But, farmers who were not in the seeded area felt that they had been cheated out of the possible benefits.

The farmers in the unseeded area brought their case to court and demanded that the state government pay them for what they lost in crop damages. They argued that it was unfair that they be "guinea pigs" in the experiments. "Why should we be left out of the benefits? The experiment was paid for through our taxes, yet we had not been given an opportunity to participate. The study committee merely selected the areas in an arbitrary way."

How did the court decide? What reasons did it give for that decision?

A. The state governments *are not* responsible for the damages because hail storms are a natural occurrence. Farmers have accepted that fact even before cloud seeding became available.

B. The state governments *are* responsible because they could have helped the farmers if they wanted to.

C. The state governments *are* responsible because they must insure that the people involved are adequately protected when they take on a project of such an experimental nature.

D. The state governments *are not* responsible because there was no guarantee that the seeded areas would benefit significantly.

PART C — What Should be the Law?

During the "You are the Judge" game you no doubt came to the realization that weather modification by "cloud seeding" creates a variety of conflicts. Rain needed by one group of people may not be needed by another group in the same area. If clouds are seeded to produce more rain in one section of the country, the section downwind may find their rainfall reduced. A number of questions thus arise:

- Can people "own" the moisture in the air in the same sense as they own property?
- Does one have the right to the clouds above one's property or just the rain that falls on the property?
- How might people be protected from harmful effects of cloud seeding?
- How does one decide if people in one area are harmed by cloud seeding in another area?
- How does one decide that increasing rainfall or suppressing hail is necessary?

At present, the laws regulating rain-making are not clear. Some states have rain-making regulations, others do not and a few have even banned rain-making altogether. For examples:

- State X claims that all moisture in the atmosphere above it belongs to the people of the state. Therefore private parties in order to seed clouds must show that their activity will not be harmful to the people of the state.
- State Y allows each county to set its weather modification regulations, and each has a right to prohibit that activity if it finds it undesirable.
- State Z puts no limits on weather modification activities and only requires that persons or companies involved in cloud seeding file a report on its activities.

In this activity you will have the opportunity to write a set of laws governing weather modification activities for a state. The characteristics of the state and guidelines for writing the laws are described below:

Law for Rainmaking in State A

State A is primarily an agricultural state and frequently has long periods of drought that result in hundreds of millions of dollars in crop loss. In times of scarce rainfall it needs to buy water from a neighboring state for irrigation and drinking, but that state has had an increase in population and is less willing to sell its water.

State A has no laws that regulate weather modification. In teams of 4 to 5 students, write a set of laws for State A that will govern weather changing activities and will adequately settle the legal questions and problems that might arise. Discuss the following considerations before you begin writing:

Considerations:

First determine who has ownership of moisture in the air. Does it belong to all the people of the state as "common property" or to the people who own the land underneath the air? If the moisture in the air is held by everyone in common, does it mean that the state can tell the property owner how much of the water that falls on his/her land he/she is allowed to use? If the moisture in the air above belongs to the property owner, does he/she have the right to make rain whenever he/she pleases even though it might have undesirable effects on his/her neighbors? Explain why you have selected your particular viewpoint.

Should the state control all weather modification activities or should this be left to private operators?

- If activities are conducted by private operators, how does one determine if the weather changers are competent?
- If the state government conducts the activities, how does it select "where" and "when" to cloud seed? What government agency should make the selections? Increased rain may not please everyone who is affected. A government agricultural agency's interest in changing the weather may be different from that of the government transportation agency.

If the rainmaking causes damages, who should be held responsible?

- How does one determine if damage has occurred? If rain, for example, spoils a large outdoor festival, is that to be considered an important loss?
- Who determines what is a harm or a damage? A benefit to one party may not be consider a benefit by the other party. (Heavy snowfall is welcomed by ski resort owners, but not necessarily by city governments which must spend large sums of money for snow removal.
- If one area loses rainfall, how can its residents recover the loss?
- Does one have to show that harm has been done to recover the loss? How does one prove that harm has occurred? (Is there any way that one can prove that a cloud seeding activity significantly reduced rainfall in another area or that it increased the severity of the storm rather than decreased it?)

If cloud seeding activities were operated by the state, who should pay for them? Everyone? Only those who benefit?

- How will the state show that it is acting in everyone's best interest? What if errors occurred in the cloud seeding procedure, and damage to property and lives resulted?

To aid in the development of the final set of laws, it would be helpful to group the laws into categories as they are presented. Some possible categories might include:

- Cloud seeding operators
- Types of permissible activities
- Management of activity
- Role of state government
- Liability rules (Who is responsible? What types of damages can be claimed?)
- Agreements between states

The Complete
Weather Modification Laws for State A:

- Examine each law in turn, and as a group decide if the law should be included in the final set of laws. In making the decision, determine if the law satisfies the following points:
- Does the law treat everyone fairly?
- Does the law violate anyone's rights unnecessarily?
- Are people and their property adequately protected?
- Compile the set of laws for State A. Examine them as a whole. Determine if any regulations conflict with others and make the necessary changes.

Optional Activity:

Obtain from your state government its laws regulating weather modification.

Compare these with the laws developed by the class. How are they similar? Different?

Are there any important aspects that are not covered by the state's laws? Your laws?

Would you recommend any changes in the existing state laws?

- Should the state have to obtain permission from the people of the area each time it engages in cloud seeding?
- Do people need to be warned that cloud seeding activities will take place?

How does State A respond if a neighboring state claims that cloud seeding has robbed it of its rain?

- Is State A only responsible for the welfare of its own residents and not to the people of the other state?
- What types of agreements have to be made with neighboring states?

Procedure:

Meet in your groups to discuss the above considerations and select a recorder to write down the main ideas brought out.

Begin by listing all the possible problems that you think might arise in weather modification activities.

(e.g.) How are different people affected? What might be their objections? On what grounds might they base their objections?

It may be helpful to refer back to the court cases in the previous game for some ideas.

Using the list of possible problems as a guide, develop a set of laws/regulations for weather modification activities in State A. The laws that you write should help to settle some of these possible problems.

When each group has completed its set of weather modification laws, all class members will meet together. At this time a spokesperson from each group will present the laws developed by the group.

The class recorder will write the laws presented on the board or display them on large sheets of paper so that they can be critically examined by everyone.

ACTIVITY 3: THE DAM BUILDERS

PART A — "People and Dams"
Introductory Readings

When man, the hunter, became man, the farmer, a reliable source of water became all the more essential. No longer did a person simply "pull up stakes" at whim and move to another stream or lake. One was now dependent on the land one plowed and seeded to produce an adequate harvest.

However, rainfall was never constant; there were often long dry seasons or long periods of torrential rain, both of which often contributed to crop loss and famine. To overcome these problems people devised ways to control the flow of water by building dams, diverting rivers and digging irrigation canals. These activities of changing the surface of the land to better serve the needs of people can be traced back to earliest history.

For example, in Chinese history severe catastrophic floods afflicted the land during the reign of Emperor Yau (approx. 2280 B.C.) He commissioned Kun, minister of works, to remedy the situation. Kun then proceeded to build a series of dams to contain the flood waters, but for nine years his efforts were of no avail. He was replaced by his son, Yü, who began by surveying the natural contours of the land and the course of water flow. Yü concluded that the river was not following its intended course because the outlets were impeded. He embarked on a massive engineering project, cutting channels through mountains, which resulted in nine new outlets for the river. This engineering feat proved to be a successful prevention measure against disasterous floods, and Yü was immediately proclaimed a national hero.

Dam building and rechanneling rivers has continued throughout history as methods of water containment, and in more recent times, the energy of water flowing through dams has been harnessed and converted to electricity. Today, dams, in addition to storing water and controlling floods, provides an important source of electricity.

While dams are a common feature along the majority of rivers in the U.S., controversies have erupted over new dam construction projects in recent years. The following excerpt from a magazine article underscores a few of the issues of debate.

Reading 4

You Can't Shoot The Rapids On A Man-Made Lake

by Rice Odell

With a flood of arguments, Army engineers seek to dam Virginia's Rappahannock, but local opponents say that their reasons don't hold water

Periodically, Charles S. Rowe, editor of the *Free Lance-Star* in Fredericksburg, Virginia, sits down at his typewriter and composes an angry editorial denouncing plans to build a huge dam and reservoir on the Rappahannock River a few miles above the city.

Rowe has called the Salem Church Dam proposal "one of the most wasteful pork-barrel projects imaginable," and has referred to local supporters of the dam as the Army Corps of Engineers' "loyal legion of lobbyists." Never mind that a long-time supporter of the dam has been his brother Josiah P. Rowe, III, who not only is mayor of Fredericksburg but general manager and co-owner of the newspaper as well.

The Salem Church controversy has all the elements of a classic environmental "crunch." The Rappahannock, which is joined by its principal tributary the Rapidan River, rises on the slopes of the Blue Ridge Mountains and flows 185 miles through hilly woodlands and pastoral farmlands into Chesapeake Bay.

All was serene until one week in October 1942, when torrents of rain — 19 inches in one place — fell in the Rappahannock watershed. The river poured a 42-foot crest of water down on Fredericksburg and nearby areas. More than 200 businesses and 180 homes in the city were covered with water at depths up to five feet; fires started at oil storage plants near the river. Damage was estimated at about $1.2 million.

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Community leaders prodded Congress for protection; Congress went to the Corps of Engineers, and the Corps concluded that it would be impractical or uneconomical to provide protection by building a large dam near the city just for flood control.

But the Corps specializes in construction; it recommended construction at the Salem Church site of a high dam with two major purposes: protection against floods by backing up floodwaters in a 240-foot-high reservoir and generation of hydroelectric power for sale by releasing the stored water.

At normal level, the reservoir would cover 21,300 acres, inundating farm and other lands in five counties; it would obliterate 26 miles of the Rappahannock River and 27 miles of the Rapidan, creating instead a series of long, twisting fingers of water with the look of a Rorschach inkblot. Annual charges for the project (interest on investment, amortization, operation and maintenance) would be $1,165,900, while annual benefits (principally the value of electric power) would be $1,774,850.

This produced an economically attractive "benefit-cost ratio" of 1.52 to 1; for every dollar spent on the project each year, it would result in benefits, or damages avoided of $1.52.

Congress authorized construction of a Salem Church Dam in 1946 — but restricted the height of the reservoir to 220 feet, chiefly because upstream farmers had howled over having so much of their acreage flooded.

But power generation would not be feasible at 220 feet so the Corps was stuck with an authorized project which, it was forced to admit in 1952, had a benefit-cost ratio too "marginal" (1.11 to 1) to justify construction. The dam project was in limbo.

In 1966, the Corps surfaced again, not only recommending a reservoir at the original 240-foot level, but showing a benefit-cost ratio of 2.1 to 1, far more favorable than before. (Annual costs of $3,464,000; annual benefits of $7,290,000.)

How did the Corps manage to revive the dam with this numerical feat? This becomes increasingly difficult as the most feasible projects are built, leaving less favorable rivers and dam sites to work with. But Congress, and in some cases the Executive Branch, have continually changed the rules by which projects are evaluated, adding to the list of benefits which the Corps is permitted to crank into its evaluations.

The Corps now could recommend a *multi-purpose* project with the following benefits (shown with the percentage of total annual benefits attributed to each):

Recreation	41.0 percent
Power generation	23.4 percent
Salinity control	20.4 percent
Water-quality control	8.3 percent
Water supply	4.7 percent
Flood control	2.2 percent

Recreation became the dominant justification for the project, while flood protection, the original reason for it,

Riding The Rapids

accounts for a mere 2.2 percent of the benefits. This may be appropriate, since there hasn't been a flood of any significance for almost 29 years.

Also the Corps found another important new peg — "salinity control." In the lower Rappahannock and its estuary there are productive oyster grounds. As the water gets saltier closer to Chesapeake Bay, the oysters are more susceptible to predators and disease. Releases of fresh water from the reservoir in summer, the Corps reasoned, would increase oyster production.

Again the dam had strong support — from the city of Fredericksburg; from bankers, businessmen and others who wished to see construction and other dam-related activity stimulate the area economy; from Fredericksburg's single large industry, the American Viscose Division of FMC Corporation, which is the largest cellophane manufacturing plant in the world and which uses huge quantities of water for both processing and cooling; from most counties and towns in the region; from oystermen downstream; from various state agencies; from all relevant federal agencies; and even from far-off Prince William County to the north which feels the Salem Church reservoir will be the most economical way to meet future water-supply needs.

In contrast to this powerful array were some 200 landowners who objected to the flooding of their farms. And then there was Randy Carter.

Carter is a Rauquier County building inspector who lives in Warrenton, well above the area which would be flooded. He is an expert, well-known, white-water canoeist, and he was particularly concerned over the proposed inundation of Kelly's Ford rapids, a long and superb stretch of bounding, rock-strewn water unique to Northern Virginia.

Carter later testified before a congressional committee that flooding this section of the Rappahannock would "destroy something that is priceless and something that nature has given us very little of. Engineers can give us flat water but only God can give us a beautiful, fast-water, mile-and-a-half like the Kelly's Ford rapids." Carter has also pointed out that the Rappahannock is "one of the best small-mouth bass streams on the East Coast." So he began to fight. He was a lone wolf for a long time, says Robert T. Dennis, director of the Central Atlantic Environment Service, who joined Carter in opposition. Carter organized the landowners and other canoeists and conservationists. He also spurred opposition to Salem Church by the businessmen and officials of Fauquier and Culpeper counties, since the reservoir would flood and remove 20,000 acres from their tax base.

Among other things, Carter urged the Corps to consider a lower dam — so less upstream land need be taken and so the reservoir, though flooding other rapids downstream, would not quite reach over Kelly's Ford. "I told them, 'You've made this report, and you've never seen the river.'"

An awkward event for conservationists

In the summer of 1966, however, Fredericksburg was plagued, not by a flood, but by a drought. The city had to restrict water usage.

The drought scare boosted support for the Salem Church Dam. "Feeling was running very high," said Samuel P. Mason, later a president of the Fredericksburg-Rappahannock Chapter of the Izaak Walton League of America. He noted that Fredericksburg (and two neighboring counties) had no long-range plans to assure a water supply for their residents. "So the dam looked pretty good to those of us who liked to drink water." In view of this, the Izaak Walton Chapter in 1967 voted in favor of Salem Church.

The drought also spurred Fredericksburg and the two counties to plan construction of small works to provide enough reserve water supplies to last until construction of the high dam. These interim actions allayed the fears of many. In 1969, the Izaak Walton Chapter voted to reverse its position and oppose the dam. There was a bitter split and the chapter lost some of its members.

Congress finally authorized construction of a 240-foot level dam in 1968. But its opponents have continued to work assiduously, compiling more arguments against it, and lining up important new allies. They claim many of the figures and techniques with which the Corps calculated its 2.1 to 1 benefit-cost ratio are bogus. Any such evaluation process, to be sure, is more art than science.

On March 18, 1970, Senator William Proxmire of Wisconsin accused the Corps in general of using various unsound and improper evaluation procedures: "They include the consistent overestimation of the economic benefits. They include the understatement of the cost of these projects. They include the neglect, indeed disdain, of the environmental disbenefits which appear as side effects to the manipulation of natural rivers. They include the use of very low interest rates to evaluate the present worth of the future impacts of these projects, a practice which artificially bloats the benefit-cost ratio."

The Salem Church opponents claim that the Corps did not sufficiently explore all alternatives to the high dam. They scoff at the Corp's cost estimates for the 47,453 acres of privately owned land the government would have to purchase — an average $60 for a wooded acre and $200 for a farmland acre. This year Mayor Rowe noted that to buy land for its smaller water-supply impoundment, the city paid almost $1,500 an acre for "remote woodland."

The dam's opponents also challenge the very need for its benefits, as follows:

Flood Control — Salem Church wouldn't eliminate all flood damage, and the Corps has inflated its estimate of damage that would be prevented, it is said. Much of the serious damage in 1942 was caused by a local flash storm that poured rain over an already flooded area. Damage would have been far less had there been more than a few hour's warning.

Water Supply — Smaller impoundments, such as those already being built, are seen as an answer to water-supply problems for decades. Prince William County is considered too far away to be justified in relying on the Rappahannock for its water.

Water-Quality Control — "Low-flow augmentation," or releasing water to dilute and flush pollutants downstream, is viewed as an improper substitute for requiring industries and municipalities to treat their wastes before discharge. Dam opponents wonder how relevant this benefit of Salem Church will be if waste-treatment technology improves significantly after the dam is built.

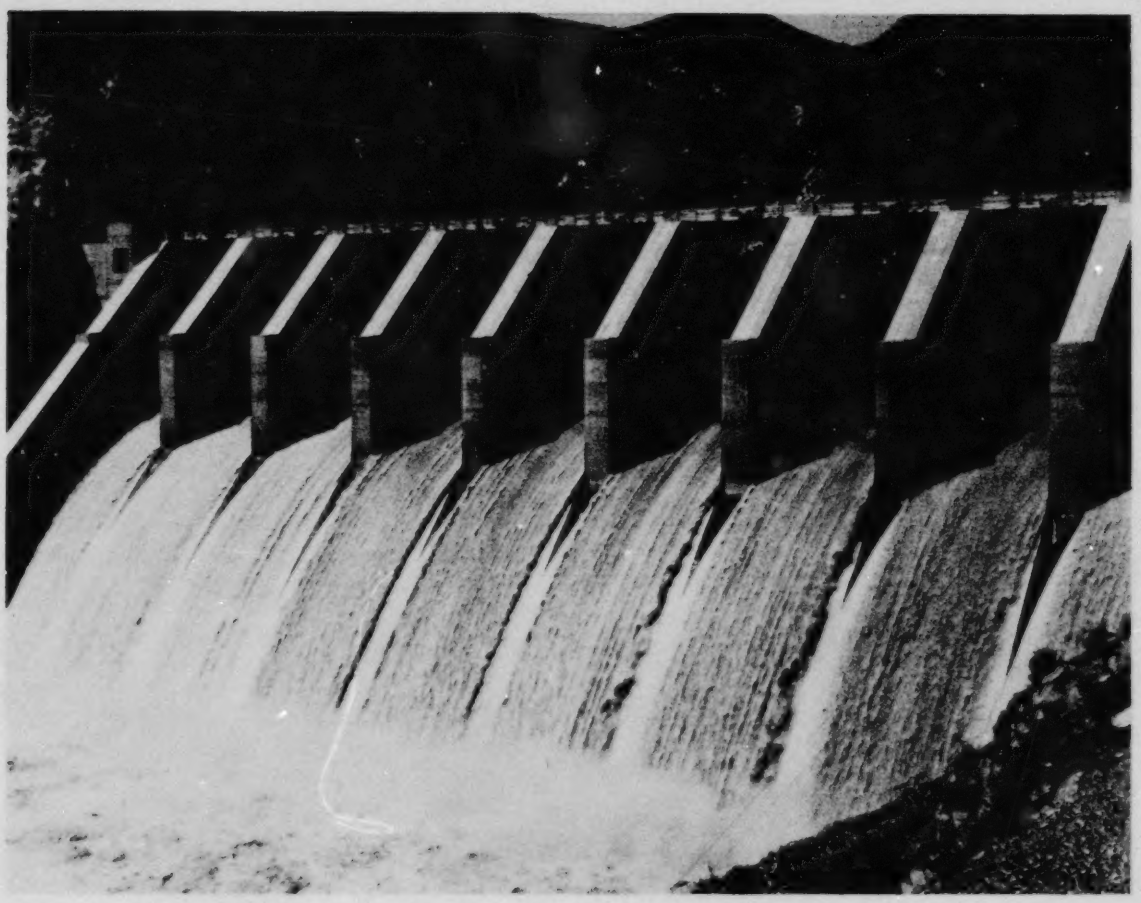
Power Generation — Dam opponents say the power capacity at Salem Church (89,000 kilowatts) is not needed and would be a mere spark next to the vast capacity of the huge North Anna nuclear power plant which is about to be built nearby by Virginia Electric and Power Company (initial capacity 800,000 kilowatts, later four million).

Salinity Control — Salem Church opponents doubt the efficacy of using controlled water releases to increase oyster production or of timing them accurately enough to discourage the oysters' enemies. Carter put it this way: "We do not see why we should have our dirt farmers in upper Frauquier and Culpeper counties flooded out for the benefit of oyster farmers a hundred miles further downstream."

Recreation — Most of all, Salem Church opponents attack the project's heavy reliance on mass recreation. The dam has become a classic illustration of the basic, irreconcilable conflicts between two different types of recreationists — between two different types of personalities, really, seeking to use the same waters. On one hand are the stream fisherman, the hiker, the hunter, the canoeist — the "purists" who like their nature in the raw, with its quiet and reflective solitude. On the other hand are the outboard boater, the water skier, the swimmer and picnicker — the mass, "flat-water" recreationists who gravitate more to each other and to facilities provided for them, though they too are learning to dislike crowding.

The so-called purists have had two strikes against them in trying to counter the Corps' arguments. For the Corps, with earlier assistance from the Interior Department's Bureau of Outdoor Recreation (BOR), worked up a strong statistical case to show that the 27-mile long reservoir would be a recreational boon for everyone within many miles. The reservoir's 21,300 acres would, said the Corps, be "ideal for skiing and boating." Its meandering 420 miles of "pleasing shoreline and sheltered coves" would attract fishermen, picnickers, swimmers, hikers and campers. BOR and the Corps gave each visitor-day a value of one dollar. Since the *average* number of visitor-days per year was estimated at 3,580,000, the total recreation benefit was a staggering $3,580,000 per year.

To get *net* benefits, the Corps had to deduct the present recreation values. BOR estimated that only 300 canoeists a year used the stretch of the river to be flooded. It gave each white-water canoeing day a value of three dollars, and thus arrived at the grand total of $900 a year in canoeing benefits to be foregone.



An Immense Man-Made Waterfall

Reading 5

Daniel Boone's Wilderness May Be Tamed By A Lake

by Alton Marsh

With time running out, bitter homeowners and conservationists are suing to forestall Corps of Engineers' dam in Red River Gorge

"I don't feel like I'm going to leave. I'd rather die," said Jimmy Skidmore, his usually ruddy, cheerful face clouded with anxiety.

Jimmy Skidmore is anguished because his modern brick house sits on the spot where the U.S. Army Corps of Engineers would like to place an 1,800 foot-long earthen dam.

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The Corps sees the steep canyon walls of Kentucky's Red River Gorge as a natural reservoir for water impoundment. Present plans call for a 141-foot-high dam that would slowly begin to create a lake covering 1,500 acres, and the impounded water would back up 15 miles along the Red River (one of a number of rivers in the United States with the same name).

When the current $34.1 million project was authorized by Congress in 1962, the Corps proposed placing it in the narrow valleys of the heart of the gorge, in what the U.S. Forest Service calls the "geological area," where 84 natural rock arches have been sculpted from an ancient seabed over a period of 60 million years. Public opposition forced a move in 1969 to a site in a wide farm valley just below the gorge.

Despite the lapse of years and change of site, public opposition to the dam is as intense today as it was in the late 1960s. In fact, it is now the basis for a legal battle. The Red River Gorge Legal Defense Fund is suing the Corps on behalf of Kentucky chapters of the Audubon Society, "Save our Red River," the Sierra Club and individual landowners. With an injunction currently holding up construction of the dam, the case is now before the U.S. District Court in Louisville.

In recent months, environmentalists from 18 states have pledged their support to the Defense Fund. Some 44,000 people, mainly from Kentucky and southern Ohio, have signed petitions against the project for presentation to Kentucky Governor Julian Carroll. Two thousand people have marched on the state capitol in Frankfort in a peaceful protest. The U.S. National Park Service has proposed a "natural landmark" status for the gorge, declaring it one of the finest examples available of geological and ecological resources in the Appalachian Plateau.

But, undoubtedly, the most heartfelt of the opposition comes from Jimmy Skidmore and 54 of his neighbors, whose homes would be removed to make way for 60 feet of water behind the dam.

Jimmy is a relative newcomer to the valley, his family having arrived only 100 years ago. Most of the valley residents are descendants of settlers who came around 1800, about the time Virginia's Governor Patrick Henry made a private land grant of thousands of acres in the gorge. Included in that tract is the small farm belonging to H.B. Farmer and his wife Tressie.

"When something like this comes to destroy you, you have to go all out," Farmer said recently. So he made the supreme effort. At age 70 he bought his first typewriter. "The dictionary burned in a house fire in 1944," explains Farmer, who had never found it necessary to replace it. He has only a few years of schooling, and must look up words he wants to use by reading through newspapers and magazines. it takes a long time to complete one of the letters, but Farmer has now written more than 300. "This is Eden," Farmer said one day, motioning toward a brook behind his home where dogwood blossoms were reflected in the ripples.

The Red River Gorge is located along Mountain Parkway, 70 miles southeast of Lexington, within the Daniel Boone National Forest. It was in this wilderness 200 years ago that Boone discovered "nature was a series of wonders, and a fund of delight. Here she displayed her ingenuity and industry, in a variety of flowers and fruits beautifully colored, elegantly shaped, and charmingly flavored; and we were diverted with numberless animals . . ."

Visitors today are no less charmed by the haunting beauty of white water, stands of tall timber, the multicolored carpet of gentians, Dutchman's-breeches, cardinal flower, Indian pipe and trout-lily, viewed from such vantage points as "Angel Windows," "Cloud-splitter Rock" and "Pinch-em Tight Ridge." To many people, preservation of this "little Grand Canyon" of the East is a must.

Everyone knows the environmental effects on the gorge would begin to be felt as soon as the Corps moved in the first bulldozer. Some wildlife, including raccoon, gray squirrel, deer, grouse and beaver, would be frightened away by the noise of construction. They would flee to join wildlife in neighboring habitats, resulting in overcrowded living conditions that would soon exhaust the food supply. Some will die, according to Corps documents, including a unique colony of corn snakes.

The overall character of the geological area, where 763 species of plants have been found — including 14 that are rare and endangered — would begin to change. Forty-seven plant species, including four known nowhere else in Kentucky, would be flooded. At one point in the gorge a rare association of beech, sycamore, tulip poplar, hemlock, basswood, sugar maple and other trees would be killed.

"I think there will be a change in plant life," Colonel James Ellis, Army Corps district engineer, said in an interview in his Louisville office. "I don't know if that's for the better or worse. You might find out 15 or 20 years from now we have a hardier, more attractive plant life down there."

When Dr. Mary E. Wharton, retired after 27 years as head of the biology department at Kentucky's Georgetown College, heard about the colonel's comment, she replied, "Botanists, however, think the present, uncommon plant species will be replaced by the more common box elder, willow and poison ivy."

Botanists from many Kentucky colleges now use the gorge as an outdoor laboratory. But its value in that capacity would be greatly diminished by the dam, according to Dr. Wharton and Dr. Roger W. Barbour, a biologist at the University of Kentucky. The wide range of habitats, from moist valleys to the dry ridges, provides a diverse environment capable of supporting numerous species. Drs. Wharton and Barbour have taken classes to the gorge for 25 years, and they have co-authored two popular reference books — *A Guide to the Wildflowers and Ferns of Kentucky and Trees and Shrubs of Kentucky.*

Geology students also find the gorge an exceptional learning area. University of Kentucky Professor Carl M. Clark has termed it a "geological art gallery." The arches such as the popular Sky Bridge, high on the point of a ridge, and Gray's Arch, large enough to hold a moving van, are spectacular enough, but deep in a seldom-visited portion of the gorge is an "arch within an

arch" formation. Called "Cherokee," the 90-foot-long natural bridge was formed inside a huge cave or "rock-house." It is 50 feet high and seven to eight feet thick. While the arches in the upper gorge would not be flooded, it is the overall change in the character of the whole area that Kentucky scientists fear. One special concern is that the valley floors in the geological area may become mud flats.

Archaeologists have clearly identified signs of pre-historic Indian cultures — Archaic, Woodland and Fort Ancient — in the gorge area. It is estimated by Wesley Cowan, University of Kentucky field archaeologist, that 31 of the sites left by these cultures would be inundated by the reservoir. (The Corps says federal funds would be available for an archaeological excavation before the waters come.)

Corps officials repeatedly remind the public that they have a "mandate from Congress" for the dam project. Unless Congress changes its mind, they make it clear that they plan to proceed with preparations for construction.

Their justification for the dam is based on several claimed benefits. The strongest of these is that the dam will reduce flooding at Clay City, a community of about 1,000 downriver from the dam site. Yearly floods often damage crops in the area, but the last serious one affecting the town occurred 13 years ago.

Opponents point out that the dam controls only the North Fork of the river, and that flash floods could still occur at Clay City from the Middle and South Forks. The Corps admits this, but says its project was never meant to stop flooding — only to reduce it. A flood so serious that it can be expected to occur only once in ten years or more will thus affect only 4,500 acres, not 7,200 as at present, the Corps says.

Dilemma 1 — MAKE WAY FOR THE DAM

Gene Tucker held steadfast. He and his family were not going to move. He had labored long and hard for his 200 acres of fertile farmland and was not about to give it up. His farm was his entire life, and no one was about to take it away from him! Gene was not going to follow along with his 50 other neighbors who meekly sold their farms. He was going to stay and fight the government and its plan to build the dam. If the dam was built, his farm would become part of the newly formed lake.

John Sneed, sheriff of the county, had known Gene since their school-boy days. He tried to talk some sense into Gene, but without success. Gene was stubborn. John in the meantime, received world from the Engineer Corps informing him that construction was to start in a month and all persons living in the affected area were to be evacuated. John's task was to make sure all persons left. He realized that the only way to move Gene and his family was by force. He and his deputies could certainly get the Tucker family out once they appeared armed with guns.

Should John follow his orders and force the Tucker family to move? Why?

DISCUSSION QUESTIONS

- Why should it be important for John to follow his orders?
- What should be John's most important consideration in making his decision? Why?
- Should the fact that Gene was a friend for many years make any difference in John's decision? Why or why not?
- Should a friend be treated any differently from anyone else? What if he didn't know Gene?
- If the government decides that a project is necessary and has many benefits, does it have a right to force people to sell their property? Why or why not?
- Does a person have a right to his/her property even if it prevents the construction of a public project? Why or why not?
- How does the government determine that it is being fair to everyone?
- Is Gene being selfish by wanting to keep his farm and stop the dam from being built on that location? Why or why not?
- Is there anything that the government can do to try to help Gene and his family? Should it be expected to do that? Why or why not?
- If the government pays Gene a fair price for his land, shouldn't that be enough? Why or why not?
- How should the government, or anyone for that matter, decide on building projects that would displace many residents?
- What reasons are there for Gene to abide by the government's decision as his neighbors did?

Reading 6

We Must Decide Which Species Will Go Forever

by Thomas Lovejoy

. . . There is increasing awareness about endangered species such as the California condor (Smithsonian, March 1972). The problem is generally confronted on a species-by-species basis: the Mauritius kestrel with nine individuals; the whooping crane with 85 (61 wild birds, 24 in captivity); the Sumatran rhinoceros with fewer than 50. That there are endangered species of plants as well — some 20,000 of them worldwide — is unknown to most. Generally, the whole lot of endangered species seem to be Lewis Carroll creatures with a rather never-never-land existence. It is symptomatic that many people believe the dodo's existence was confined to *Alice in Wonderland,* rather than being one of the first birds exterminated in historic times.

One of the most fundamental units in nature, the species is one of the easiest for the human mind to grasp, unfortunately leading people to think of endangerment and extinction as a series of discrete events, rather than as something that takes place at an estimable rate. Extinction is not only as old as the history of life on our planet, but the usual fate for an overwhelming majority of species. These natural extinctions were usually caused by the evolution of new, more competitive and successful forms of life or by normal environmental change. The extinction rate has fluctuated, but in general it has increased. At the same time, the number of extant species on the planet has continued to increase, with only occasional minor setbacks, until today the total species number somewhere between three and ten million.

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At least within historic time, however, and more likely going back into the Paleolithic Age, a new and insidious extinction process has been introduced. In addition to natural ones, man-made extinctions have been occurring — at first quite selectively to eliminate competition or dangerous animals, or by overexploitation of large edible species (it is known prehistoric Man caused the disappearance of at least such large animals as the elephant bird or roc of Madagascar and the giant ground sloth of the New World). Increasingly, Man has exerted stress, often not deliberate, on the ecosystems of the planet. These systems respond by shedding species just as a plant sheds leaves in response to the stress of drought or cold, and once a species is shed by all the ecosystems in which it naturally belongs, extinction results. The result is impoverishment of the biota of the planet, a reduction of its ability to support Man and other forms of life. The problem of endangered species is not, therefore, a hypothetical one, as some may wishfully believe; biotic impoverishment is an irreversible process that has profound consequences for the future of Man.

There is no question that extinction rates are accelerating. A graph of historic extinctions of birds and mammals follows the same curve as one for human population growth, but the real extinction rates of historic times are undoubtedly several times higher — because, among other reasons, it is almost impossible to remove a single species from an ecosystem without taking dependent species with it.

Today, with soaring human population increase and with the technological ability to assault nature improving to the point where we are capable of wiping out entire ecosystems, extinction rates are going upward exponentially. This is taking place long before the inventory of the planet's species is anywhere near completion. Scientist have described over a million species — perhaps as many as one and a half million — leaving the job 50 to 85 percent incomplete, depending on what estimate one takes of the total number of species on the planet.

Species are becoming extinct today before they are known to Man. Usually we remain in eternal ignorance of what we have lost. Who on receiving a package would toss it out before looking inside? Yet that is what we are doing with our biological heritage.

The tropical forest regions of the globe are some of the richest, both in terms of total species numbers and in terms of undescribed species. Probably only half the fresh-water fish species in the Amazon drainage and fewer than half the soil mites of Amazon soils are known to science. Yet the tropical rain forest is being destroyed at an unprecedented rate. Two-thirds of the southeast Asian rain forests are gone, half of the African rain forests, and more than one-third of the virgin forests of the Amazon have been cut over.

Many of the species of these virgin forests are completely dependent on this primary vegetation and will join the dodo in oblivion if all these forests are cut. Luckily, in the Amazon at any rate, the cutover areas are patchily distributed. Although substantial numbers of described and undescribed species have probably

The American Bald Eagle

become extinct within the last few years, we have not lost the huge number that would have gone had a contiguous one-third of that forest been cut. . . .

Among the first species to go are large animals, ones requiring large land areas for existence, and often at the end of long food chains. We have little idea of what consequences removing a species at the end of a single food chain would have for an ecosystem.

Many of these first species to go are quite secure under natural conditions, but that very security makes them singularly vulnerable to unnatural disturbance by Man. Island species are typical examples; with small populations, they are in equilibrium with their insular environment which, once breached, is too small to afford opportunities for escape. Many of the large animals have a similarly vulnerable security; as species of stable environments, they have evolved to be closely in tune with that stability, and in doing so have sacrificed the ability to recover rapidly from disruption. They live long, begin reproduction late in life and have few young. Whales, whooping cranes, great apes, elephants — all are similarly vulnerable for this reason. . . .

Can we possibly save a representative series of species as living museum collections, scattered in various protected ecosystems throughout the world? If this were possible, then once Man's mad assault on the natural systems of the planet abates, once the enormous population increases already essentially inevitable are checked and population diminishes to reasonable levels, and if only we haven't spread too many poisons about, *then* might a portion of the planet be reclaimed by the wild? Even given all the ifs, it would not be possible without that representative series. Extinc-

tion is permanent, final. Man with all his terrifying ability to destroy species and ecosystems will never have the power to resurrect even a single individual of even one species he has eliminated.

Environmental triage has not been widely practiced in the past. When the numbers of endangered species were small, it did not seem necessary to choose between trying to save the ivory-billed woodpecker or the whooping crane. With longer and growing lists of endangered species such choices are being forced. Man's appetite for cellulose is so insatiable it would shame a termite; is it then realistic to try to save hole-nesting birds such as the Puerto Rican parrot (20 birds) which require large old timber tracts?

Should triage be based on the ease or difficulty with which a species might be saved? perhaps we should write off the most endangered species and concentrate on those for which our efforts won't be easily jeopardized by random events. Would it be wiser to take the $15,000 currently devoted yearly to the nine Mauritius kestrels and use it to establish a reserve for the 100 or so St. Lucia parrots, or a reserve for the pigmy hogs of the Terai of Assam and possibly Nepal, once thought to be extinct but rediscovered in part through the efforts of Gerald Durrell's Jersey Wildlife Preservation Trust (see Smithsonian, September 1972)? Should we try to save the leopard rather than the cheetah, because the space needs of the latter are so demanding? Would the conservation community suffer a loss of faith if an endangered species were to be deliberately written off, or is it the only way the point can be made about the plight of the world's animals and plants?

Reading 7

The Endangered Species Act

by Kevin Shea

In Youngstown, Ohio, a common pleas judge recently ruled that pigeons do not have constitutional rights. The U.S. Constitution guarantees the life, liberty, and property of citizens, noted Judge Sidney Rigelhaupt, but "the court can find nothing in the Constitution which guarantees similar rights to pigeons." With that pronouncement, the court lifted a temporary restraining order preventing the city health department from poisoning a flock of downtown pigeons. The judge was right, of course, but had the city been faced with a plague of long-tailed ground rollers or light-footed clapper rails the outcome of the case might have been entirely different, because those two birds — along with several hundred other animals and a few plants — have been designated by the Department of the Interior as endangered species and placed on the department's endangered species list. As will be seen, once an animal is placed on the list all members of that species are, in a sense, guaranteed life and liberty. Furthermore, if you can call their habitat property, that may be guaranteed as well.

The law that grants this protection to certain nonhuman residents of the U.S. (some protection is also afforded species in other countries) is the Endangered Species Act of 1973, which is just now being recognized as one of the toughest and most uncompromising environmental laws ever passed by the U.S. Congress. Already, legal actions brought under provisions of the act have halted two major federal water projects and forced the Department of Transportation to relocate an interchange on a federal highway in Mississippi. But that seems to be only the beginning. According to the U.S. Fish and Wildlife Service, which is the Department

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of the Interior agency responsible for carrying out the provisions of the act, the endangered species list soon will include about 120 different aquatic animals living in habitats threatened by government dams. Furthermore, it is fairly certain that, as environmentalists discover the unyielding nature of the act and the broad opportunity it provides for bringing legal action, we will be hearing a great deal more about madtom catfish, pearly mussels, and furbish louseworts.

Congress is becoming restive about these developments, and many congressmen who voted for the act (passed by a unanimous voice vote in the Senate and a vote of 355 to 4 in the House), thinking they were voting to save bald eagles, leopards, and timer wolves, were unaware that their vote might help slam the lid on the pork-barrel. As one congressional aide put it, "If you start cutting public aid projects, you'll have a hue and cry from every congressman and congresswoman in the country." At the present time there are three bills, two in the House and one in the Senate, that would weaken certain parts of the act to allow federal projects to proceed.

What the Act Does

The purpose of the act is quite simple. Beginning in the last half of the nineteenth century and continuing until now, the rate at which animals and plants were becoming extinct increased rapidly. The overwhelming majority of these extinctions were caused by people, through habitat alteration, hunting, and perhaps even pollution. The Endangered Species Act is an attempt to slow the rate at which species are becoming extinct by singling out those plants and animals that are thought to be near extinction (endangered) and giving them special protection. In the words of the act itself, it is a measure "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved (and) to provide a program for the conservation of such endangered and threatened species."

The chief "provider" is the federal government itself. The act declares it the policy of Congress that all federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purpose of the act; several specific provisions of the act implement this purpose.

One can imagine the palpitations the act caused among federal bureaucrats reading it for the first time. Federal agencies must "use all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided . . . are no longer necessary." That is how the statute defines conservation. The definition goes on to give some ideas on what methods might be used to conserve endangered species but is careful not to limit the methods to those mentioned. It should also be noted that the definition does not say that agencies shall use all *practical* methods to conserve endangered species but rather all *necessary* methods.

Probably the most potent definition in the statute and the one causing the most consternation on Capitol Hill is the definition of "fish and wildlife." To most of us, those words mean animals we catch with a rod, shoot with a gun, or look at through binoculars. We may now add those we look at through a microscope or smash with a fly-swatter. In the statute, "fish and wildlife" means any member of the animal kingdom, including, without limitation, any mammal, fish, bird, amphibian, reptile, mollusk, crustacean, arthropod, or other invertebrate, as well as any part, product, egg, or offspring thereof, or the dead body or parts therof.

Since one of the major prohibitions in the act is that which deals with "taking" endangered species, the definition of "take" is also important. In the statute, "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, or collect or attempt to do so. In the regulations issued by the secretary of the interior to implement the law, however, "harass" came to mean an intentional or negligent act or omission which created the *likelihood* of injury to wildlife by *annoying* it to such an extent as to significantly disrupt normal behavioral patterns. In other words, it is never a good idea to be in the presence of an endangered species, since unintentional harassment could occur.

Not only that, it may not be a good idea to be in the presence of a species that *looks* like an endangered species, for it may be listed, too. The act gives the secretary of the interior authority to list animals or plants that are so similar in appearance to listed species that it makes protection of the endangered species difficult. While this is a little-used section of the act, it has very broad implications, since closely related species are often difficult to distinguish. The most useful purpose of this section is to prevent the importation of commercial products which are derived from endangered species but enter the U.S. labeled as products from nonprotected species.

Dilemma 2 — The Endangered Plant

A botanist, conducting a study of the river valley soon to be covered by a lake created by the new dam, came upon a startling discovery. While walking along the river's edge, she found a plant long thought to be extinct. It was a slender fern-like plant with small yellow blossoms, a distant relative to the snap dragon. Exploring further, she discovered that clumps of these plants grew only along a certain stretch of the river.

The news of her findings quickly spread through newspapers and scientific journals. The local environment groups were jubilant over the discovery. However, the joy was soon displaced by the realization that the power project and dam construction would destroy all these plants growing along the river bank.

Although the $700 million dollar power project was well underway, the environmental groups felt that nothing should stand in the way of preserving this special plant. Since it was found nowhere else, the unique condition of this river must be the reason for the plant thriving there. The dam would flood the area and destroy forever this plant. They argued that dam construction simply had to be stopped!

The environmentalist brought a lawsuit to halt the dam construction. They contended that this plant had been placed on the endangered species list and was protected by the Endangered Species Act of 1973. Any government activity that would change or destroy the habitat of a threatened species had to cease.

Supporters of the power project, on the other hand, argued that the dam would bring new benefits for the people of the state. The dam would help control floods, produce electric power for homes and industry, and provide lake recreation.

The case was presented to the court for a decision. Should the judges order dam construction be halted? Or, should the judges permit the construction to continue? Why?

DISCUSSION QUESTIONS

- Should the fact that the dam is near completion be an important consideration when the judges make their decision? Why or why not?
- Since this plant is listed as an endangered species and protected by law, is that reason enough for the judges to stop construction? Why or why not?
- If the plant species has little value to people (e.g., food, shelter, medicine) should that make any difference in the decision? Why or why not?
- Is it more important to protect only plants which have known benefits to people? Why? What if a benefit (e.g. cure for cancer) were discovered after that species became extinct? Is that important to consider? Why or why not?
- Biologists argue that a wide diversity of plant and animal life is important to the survival of all life on this planet. Should this be an important idea for the judges to consider? Why or why not?
- Through people's various activities many species of life have been extinguished or threatened. Should people change their ways, even if it means making great and costly sacrifices? Why or why not?
- If a plant or animal species interferes with the needs of people, should that species be allowed to perish? Why or why not? What if there was an urgent need for drinking water? Recreation?
- Do people have the right to determine which species should survive and which should perish? Why or why not?
- Should plants and animals have a right to survive? Why or why not?
- How can the rights of plants and animals be best protected?
- Should it be important for people to try to protect all species of life? Why or why not?
- Suppose the group which brought up the lawsuit had been fighting the dam to keep the river unchanged for white water canoeing and used the plant as the excuse for protecting their recreational area. Should that make a difference in the judges' decision? Why or why not?

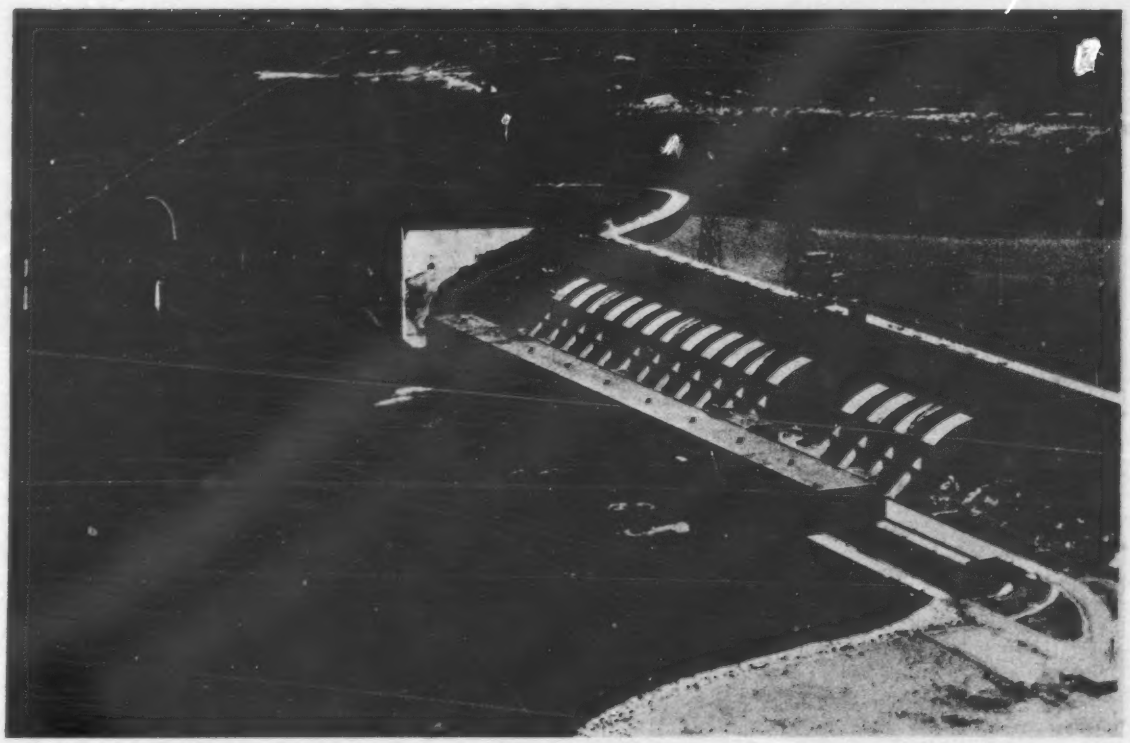
Activity 3: The Dam Builders (continued)

PART C — Distributing Power in the Northwest

Background:

A serious battle is currently raging in the Northwest. The controversy is over who should get the electric power produced by the series of dams built along the Columbia and its tributaries. These federally built and operated dams supply 80% of the electricity for the Northwest. When the dams were originally built, there was an excess of electricity and the government power agency, Bonneville Power Administration, was able to offer the power at a very low cost. This low cost power, about one half the rate charged in other parts of the country, attracted industry, particularly the aluminum smelting companies.

The situation of abundant electricity has since changed. With population growth and increased electricity demands there is no longer enough electricity to go around. The agency now wants to stop supplying power to privately owned utility companies. Much of the problem stems from the original policy guidelines for selling electricity to potential customers. The policy establishes three classes of customers:



Electric Power From The Dams

Industrial Users: To attract the aluminum industry to locate in the area the agency offered long-term contracts. The contracts also guaranteed the consumer large amounts of electricity at reduced rates. At present these companies use one-third of the power production.

Public Utilities: These utilities are operated by state or local governments and have first priority to purchase the agency produced power. Most Washington state residents are served by the state run public utility. Since the utility buys power from the government agency, Washingtonians pay less for power than residents in other areas.

Private Utilities: These utilities are owned by the investors of the company. Most of Oregon is served by private utilities. They have last priority to the power and do not have long-term contracts with the agency. With each subsequent year they receive less and less of the power.

At present, the private utilities want to reestablish as public utilities (city or state run). In doing so, they can then qualify as first priority customers. They will be

eligible to be first on the list for the electrical power. However, the agency claims that it does not have enough power and refuses to accept new customers. It argued that it cannot meet the new requests without dropping its old customers.

How should this problem be resolved to everyone's satisfaction?

Customer Viewpoints

Aluminum Industry

"We are one of the most important industries in the Northwest and supply one-third of all U.S. aluminum. The demand for aluminum will continue to increase as more cars are built with aluminum. Aluminum cars are lighter weight and therefore use less gasoline. We may use a large amount of energy in our smelting process, but in the long run we are helping our country conserve energy by making it possible to produce lighter weight cars."

"The main reason we moved our plants here is that we were promised low cost electricity. The agency signed contracts that guaranteed us electricity to meet our needs for the next twenty years. Without sufficient electricity we will be forced to close down or move elsewhere. Relocation will run in the hundreds of millions dollars. The cost of electricity elsewhere is three to five times more. If that happens, the price of aluminum will soar. Think of all the products that require aluminum. All these products will cost more if our production costs increase. Additionally, the 12,000 workers that we now employ will lose their jobs."

Utility Companies in Washington—(publicly owned)

"The power that we buy from the agency serves over 65% of the state's residents. It is important that the cost of electricity be kept low, because the homes built here are all electric. Therefore, homeowners require large amounts of electricity. If the costs go up, the poor and retired people on fixed incomes will be in deep financial straits. We must look out for the welfare of the people."

"Moreover, we have, by law, first priority to the power. When the agency was established, the law gave it permission to sell power to industry only after all residential and farm demands had been served. The law gives us the right to the electricity."

"If we have to produce our own power we would have to build coal-fired or nuclear plants. Coal plan.s would dirty our air. Nuclear plants would present radioactive dangers. We certainly do not want to endanger the health and safety of our residents."

Utility Companies in Oregon—(privately owned)

"Our residents have never benefited from the hydroelectric power from the dams built with federal money. Yet, they, too, as taxpayers should be entitled to something. For example, the cost for the same amount of electricity for persons living in this state is over two and one-half times more than that for persons just across the river in Washington. That doesn't seem fair."

"A bill has just been passed for the state to take over the operation of all private utility companies. Being a public utility should give us first priority to the BPA power, but the agency now tells us that it would not accept new customers."

"With increases in our state's population we will need more electric power. We can build more coal-fired plants, but high construction costs will add to the cost of electricity. Also air pollution is becoming a serious problem in our largest city. The coal plants will further aggravate the problem."

"It is time that we receive a share of clean, inexpensive hydro-electric power. Why can't there be some way for all of us to benefit?"

Resolution of the Dispute

Procedure

- **Group Meeting** — Meet in groups of three. Each person will select one of the classes of power customers (Washington, Oregon or Aluminum Industry) and represent its point of view.
- Based on the background information and your own ideas, present the arguments for your position and offer what you think is the best solution to the problem from *your point of view*. (Remember it is important to insure that you have enough electricity to meet your needs.)
- After all the arguments and viewpoints have been presented, discuss the possible solutions. Do any of the solutions best satisfy the needs of everyone? If the solutions were modified and some compromises were made, will everyone be satisfied?
- Try to come to an agreement with your group members on a solution that will be fair to everyone. Summarize that solution into a 3-5 minute presentation to be presented at the next class meeting. Include an explanation as to why you think the solution will best resolve the dispute.
- **Class Meeting** — A spokesperson from each group will present the group's solution at the meeting of the entire class. Class members at this time will have an opportunity to question each of the presenters.

At the end of each presentation, each presenter will briefly outline the essential elements of the solution on the board. These solutions will be judged by the class members after all presentations have been made.

The Vote — Each member of the class will cast one ballot for the solution he/she believes will best solve the problem. Which solution received the greatest number of votes?

Section II:

Unplanned Environmental Changes

ACTIVITY 4: HUMAN ACTIVITY AND CHANGE

A Man-Made Environment

INTRODUCTION:

"For thousands of year, men have dreamed of natural pleasures in some mythical Arcadia, but they have spent a very large percentage of their waking hours toiling to modify nature. Even stronger than man's biological urge for natural ways of life is his conviction that he can and should transform the world to make it a better and happier place. This was symbolized by the ancient Greeks in the myth of Prometheus, the demi-god who stole fire from Zeus and brought it down to man. According to the Prometheus myth the control of fire made man superior to animals by enabling him to make tools, warm his dwellings, engage in trade, develop medicine, and create the arts.

There is no indication in the myth – or in reality for that matter – that Promethean man is happier than Arcadian man or than wild animals. But he differs from them in deriving a uniquely human satisfaction from manipulating nature to create new patterns and new values according to his desires. In Aeschylus's play Prometheus Bound, *the demi-god takes immense pride in having enabled men to use nature for their own ends and thereby to become really human.*

Promethean man believes that, through his techniques and his labor, he can re-create paradise by imposing order on the chaotic wilderness. During the Middle Ages, the Benedictine monks even felt it was their duty to improve nature, as if they were acting as partners of God in completing the Diving Creation. They used fire, windmills, and watermills to convert wilderness into a modified form of nature more suitable to human use, more pleasing to human eyes, and, as they believed, more appropriate to the worship of God."

Rene Dubos, *A God Within*, 1972

In the preceding selection, Rene Dubos identifies modern man with the Greek god, Prometheus, who uses his skills and tools to dominate nature. In doing so, nature undergoes changes. Human activity is thus seen as a continuous process of changing the natural world to serve human needs and to reinforce people's sense of superiority.

- Do you think this is an accurate description of human nature?
- What types of evidence support Dr. Dubos' contention?

One can, with certainty, say that any activity produces change. Some changes, however, seem so minor and insignificant that they go unnoticed. Others, of course, are major changes that bring about further and perhaps different types of changes.

For example, consider an activity in which you took part during the past week. Examine that activity following the format shown below. Answer the questions on a separate piece of paper.

TABLE 1: Example Of An Activity

1. Activity	Played a game of baseball.
2. How did you plan it?	Called friends; arranged a car pool; gathered equipment; etc.
3. What were all the things you had to consider?	Find a convenient time; check the weather; make sure everyone had a ride; etc.
4. Did it occur as you planned? What was different?	Catcher sprained his finger; lost ball; had to stop early; etc.
5. Did it change you in any way? Describe.	Felt proud of my two home runs; very hungry after game, etc.
6. Did it in any way affect people around you? Describe.	Everyone had a good time; parents took catcher to the emergency room; they were late for their dinner party.
7. Did the activity have any effect on the land or other living things? Describe.	Trampled tall grasses looking for lost ball; scared some rabbits; crushed an ant hill.

The example given on previous page may seem like an ordinary activity that has very little relationship to anything else. However, if one begins to examine each item involved, it suddenly becomes interconnected to many other things which in turn affects other types of changes. Let's think about some of these:

Cars —

transportation to/from ballfield - manufacturing steel and plastics, assembly of auto parts, building of highway and roads.

Gasoline to power cars

drilling oil wells, pipe lines, refining crude oil, shipping to gas stations.

Maintaining ballfield

planting, fertilizing and mowing grass, building backstops and bases.

Hospital emergency room

medical equipment and supplies, training doctors and nurses, record keeping.

Communications

developing telephone technology, manufacturing phones and equipment, connecting lines, repairing equipment.

Clothes worn and baseball equipment

manufacturing materials, laundering clothing, etc.

Thus, a number of other activities are involved in making that ball game possible. When one includes those items in the total picture, one can easily imagine the many ways the environment has changed in order to support that activity.

It is relatively simple to trace the many interconnections of activities which have taken place or activities in which we take part. It is more difficult to predict how the use of new technologies or the combinations of many activities might produce unplanned effects. Some effects go unnoticed for many years, but then accumulate to produce sudden, drastic and quite often undesirable effects.

The use of DDT is often the example cited to illustrate how a "miracle" insecticide has become an environmental curse. When first put into general use, farmers glorified its ability to protect crops from insect pests, easily and inexpensively. Soon insects became resistent to it, and larger quantities were required to control pests. Unfortunately, this chemical does not break down readily and remains in water, soil and animals. DDT progresses up the food chains and eventually up to humans. DDT is also found in deep sea fish, thousands of miles from where it was applied. The decline in population of many animal species can be attributed to the toxic effects of DDT.

When we embark on various activities or apply new technologies the intent is to benefit mankind. Nevertheless, in many cases, other unintended situations are created, producing undesirable results. In the activities that follow the effects of unplanned environmental changes are examined. As we become more aware of possible future effects, perhaps we will begin to plan our actions with greater diligence or rethink what we presently do.

Reading 8

Changing Climate

by Richard D. James

When people in LaPorte, Ind., want to schedule a picnic, they might do well to first check the production plans of the big steel mills in Gary, 30 miles to the northwest. The reason: When steel output goes up in Gary, more rain comes down on LaPorte. The precipitation is triggered by smoke from the mills, weather experts say.

Though scientists have long suspected dirty air might change the weather, they devoted little research to the subject until recently. But now stepped-up research indicates pollution is becoming so bad that it's altering the weather over hundreds of thousands of square miles of the United States and possibly the global climate as well.

"We're putting astronomical quantities of materials into the atmosphere, and there's no question it's affecting the weather," says Charles L. Hosler, a meteorologist and dean of the College of Earth and Mineral Sciences at Pennsylvania State University. "I'm afraid the changes are already greater than most people suspect, and there may be a threshold beyond which small changes in the weather could bring about a major shift in the world's climate."

Increased rainfall is just one effect of pollution on the weather. In some cases, the contamination actually reduces precipitation. Mounting evidence indicates, too, that dirty air helps raise cities' temperatures by preventing the escape of heat generated in the cities, prolonging their frost-free season as much as 60 days. It screens off sunlight and produces fog, hail and thunderstorms. And those who contend pollution is felt on a global scale say it has weakened trade winds, increased cloud cover and, in contrast to its effect in urban areas, lowered the earth's temperature.

The processes by which pollution changes the weather aren't fully understood, but scientists think they know generally what's happening. Man-made pollutants that are sprewed into the sky each year — an estimated 160 million tons from the U.S. and 800 million tons world-wide — have loaded the earth's air with dust.

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The turbidity, or dustiness, of the atmosphere in places with supposedly "clean" country air, such as northern Arizona, Yellowstone National Park and the Adirondack Mountains, has increased tenfold in the past decade, recent research has shown. Over the Pacific Ocean, the dustiness of the air increased 30% in 10 years, and the dust fall in central Asia, as measured by Russian scientists, is 19 times as great at it was in 1930.

The dust particles are often so small — much less than 1/25,000th of an inch in diameter — that they're invisible to the naked eye. But they are highly effective cloud-forming agents. They strongly attract water vapor, which condenses and freezes on them, forming ice crystals. These, in turn, form clouds. If sufficient moisture is present, the cloud droplets grow and eventually fall as rain.

Precipitation generated by pollution in this fashion isn't a freak occurrence. Researchers think it can happen any place where the air is dirty, and they have found several cases to support their theory. For instance, Belleville, Ill., 10 miles southeast — and downwind — of St. Louis, receives about 7% more rain annually than areas upwind of St. Louis where the air is cleaner. The added moisture falls mainly on weekdays, when pollution from automobiles and industry in St. Louis is heaviest. Belleville even gets more rain than St. Louis itself because the prevailing winds tend to blow the pollution away from the city. In the past 18 years, Belleville has had rainfall of at least a quarter-inch on 83 more days than St. Louis. All but one of those rainy days were weekdays; the other was a Saturday.

LaPorte, though, is by far the most dramatic example discovered so far. Its situation was documented by Stanley Changnon, a meteorologist with the Illinois State Water Survey, a state agency engaged in studying the area's water resources. Chicago's automobiles and factories, as well as the Gary steel mills, he explains, throw huge quantities of two rain-producing ingredients into the air — water vapor and the dust particles on which it can condense and freeze. Flying through the orange plumes of smoke streaming from stacks of the mills, researchers have found billions of ice crystals being formed.

Wind sweeps the polluted air southeastward. Many communities along the route feel the effects, but LaPorte bears the brunt. Between 1946 and 1967 it averaged 47.1 inches of precipitation a year. This was 19 inches or 47% more rain than fell at stations upwind of Chicago and the mills. There's no indication the pattern is any different now.

Mr. Changnon considers it highly unlikely that the soaking the town gets is due to chance or to nearby Lake Michigan. For one thing, during the 1955-65 period LaPorte had 31% more moisture than nearby weather stations that also would feel any effect from the lake.

Two other facts are even more convincing. LaPorte's rain pattern generally matches the number of days of haze and smoke in Chicago, a rough indication of the air pollution level. And the town's rainfall rises and falls in concert with the area's steel output. "Peaks in steel production occurred seven times between 1923 and 1962, and all of these were associated with highs in LaPorte's precipitation," Mr. Changnon says.

Sometimes pollution has just the opposite effect. Clouds can become so over-seeded that no rain falls. This occurs when pollution generates so many dust particles that none of them can attract enough moisture to grow to raindrop size. One of the best-documented examples of this is in the sugar-producing area of Queensland, Australia. During the cane-harvesting season, the cane leaf is burned off before cutting and harvesting, casting palls of thick smoke over wide areas. Downwind of these areas, rainfall is reduced up to 25% from levels in neighboring regions unaffected by the smoke.

Vincent J. Schaeffer, director of the Atmospheric Sciences Research Center at the State University of New York, believes the same process has modified the character of rain and snow over the Northeastern U.S. during the past five years. "Instead of the downpours we used to receive, we get fine, misty rains and snows in which the drops are so small they tend to drift down rather than fall," he says. "We had more than 20 of these this year. We used to see only two or three a year." Rains and snows of this type can drift great distances, changing a region's precipitation pattern, Mr. Schaeffer says.

Air pollution can produce dense fogs, too. Penn State's Dean Hosler has studied and photographed extensively a massive fog bank 1,000 feet high that forms regularly near a paper mill in Lock Haven, Pa., and spreads 23 miles down the Bald Eagle Valley. "The fog appears about a third of the time, especially in fall and winter," he says. "Normally there wouldn't be any there at all. It appears on days when little or no fog is observed elsewhere in the state. This type of thing is repeated all over the country hundreds of times in different locations."

Scientists believe violent weather occurs more often with polluted air than with clean air. Downtown St. Louis during one eight-year period averaged five more days of thunderstorms a year than a rural area 13 miles upwind with less pollution, an 11% difference. Chicago's Midway airport had 5% more thunderstorms than O'Hare Field, 16 miles northwest in an area of presumably cleaner air. And LaPorte in 14 years has had 130 days of hail, four times as many as surrounding weather stations. "We really don't know how or why pollution causes these changes," says Mr. Changnon.

Dirty air is responsible for more subtle weather changes as well. Acting as a blanket, it is one factor — along with the massive amounts of heat-absorbing concrete — that keeps cities warmer than suburbs by retaining the heat from industry, autos, furnaces and other sources. Average annual minimum temperatures in the center of Washington, D.C., for instance, run around 49 degrees, five degrees higher than outlying areas. Temperature differences are greatest on weekdays, when pollution — mainly from autos — is greatest. In New Haven, Conn., the minimum temperature on Sundays differs from the countryside by only

1.2 degrees. During weekdays the difference is twice that.

Variations of that magnitude have a great impact on the frost-free period of 197 days; in surrounding counties it's about 160 days. To find open countryside with a frost-free time as long as downtown Chicago's, you would have to go 400 miles south. Meteorologists say almost none of the temperature difference between Chicago and surrounding areas is attributable to the heat-retaining effects of Lake Michigan. The lake, they say, warms the entire region — city and rural areas alike.

A blanket of pollution also means less sunlight — a year-round average of 15% to 20% less than surrounding countryside in many cities, it's estimated. During the four months of winter, the center of London gets only about 96 hours of sunshine, compared with as much as 268 hours in the open countryside. Even at that, London gets about 50% more sunshine than it did prior to the enactment in 1956 of smoke control laws.

Not all weather-changing pollution originates with autos or factories. Scientists say jet airplane emissions high in the atmosphere are affecting the weather in many parts of the world. In some areas, for instance, pollution from heavy jet aircraft traffic has noticeably increased the cloudiness, they say. "In the alley between New York and Chicago, below which I happen to live in Pennsylvania, we get cirrus clouds 90% of the time now," says Dean Hosler. "Most of them wouldn't have been there naturally before. They are formed strictly by the thousands of jet aircraft flying overhead."

Reid A. Bryson, University of Wisconsin meteorology professor, says the same phenomenon is occurring in the air lanes between New York and London. Cloud cover in this region has increased by 10%, he estimates, and he adds that cirrus clouds could well attain 100% coverage with the advent of the supersonic jet transports.

"For every pound of fuel a jet burns it releases a pound and a quarter of water. At those heights — 20,000 to 40,000 feet — that will saturate a very large volume of air because it's so cold," Prof. Bryson explains. "It's like exhaling on a cold morning. The jets also put out dust particles, so they're providing a couple of things needed for cloud formation. And there's one jet approximately every six minutes across the North Atlantic. That makes for a lot of clouds."

Along with the greater dustiness of the atmosphere, the clouds are contributing to another phenomenon — the world-wide cooling trend, Prof. Bryson and others say. There's little argument that since 1940 the average annual temperature of the world as a whole has dropped by one-third to one-half a degree — which doesn't seem like much until you consider that the latest ice age was brought about by a temperature drop of only four or five degrees. The weather scientists argue that the dirt and clouds have increased to a point where they are reflecting away enough sunlight to override other factors that would tend to raise the temperature of the earth. One such factor is the growing amount of carbon dioxide in the atmosphere, resulting from increased combustion of fossil fuels. Carbon dioxide acts as a one-way filter, permitting the sun's rays to pass through but deflecting the heat given off by the earth.

Prof. Bryson concedes that meteorologists don't yet have enough information to predict what will happen to the climate in the future, but he adds: "The only basis we do have is to look at the past to see what did happen. Looking at the climate of the past, it is clear that small changes in the past 10,000 years had very large ecological effects and they can happen bloody fast. The end of the ice age took less than a century — kapow! It's fast, and that worries me because we don't know but what in a few years we could have a significant change that would disrupt our entire climate. And that includes where we grow corn and wheat."

Dilemma 3 — RAIN, UNWANTED AT HARVEST TIME

The midwestern farm community of Franklin resembled most of the surrounding farmlands in all respects except for one. It experienced 40% more thunderstorms and nearly 250% more hail storms than its neighbors. This climatic anomaly was explained by a recent scientific study. The report concluded that Franklin received more severe rainstorms because of its location 40 miles downwind from the large steelmills of Ross. Smoke particles from the coal fired mills had a "cloud seeding" effect on passing clouds, thereby contributing to the increased intensity of the rains in Franklin.

It was harvest time again, and the Franklin wheat farmers were "keeping their fingers crossed." They could not survive another year of heavy crop damage resulting from hail storms just before harvest. The weather had "held" up until a week before harvest; then the weatherman forecasted moisture laden clouds moving in from the west. The farmer knew that with the steel mills going full blast, spewing smoke in their direction, they would have no chance of avoiding destructive rains.

They decided that this time something had to be done to protect their crops. A group of the farmers went immediately to meet with the officers of the steelmills to ask that the mills shut down until the clouds passed. Although the steel workers were sympathetic with the farmers plight, they said that closing the mills would be impossible. They had contracts to the automakers who were depending on steel deliveries for the new fall line of cars. Already they were behind schedule. If they shut down for any amount of time, it would take several days to start up their coal furnaces again. This would mean losses in the thousands of dollars each day.

The farmers tried to get the mayor of Ross and county officials to issue an emergency order to close the mills. They, too, were of no help. The officials claimed that since Franklin was in another county, they had no power to act on their behalf.

The farmers went home dejected. They were depending on this crop. Without a decent harvest this year many were destined to lose their farms. They had worked years for their farms, and this storm could literally wipe them out. As they discussed their bleak prospect, one farmer came up with a suggestion. He said, "We have no choice but to try to protect our own farms. We may not be able to stop the clouds from passing, but we can certainly stop the mills. I suggest that we join together, sneak into the mills and shut down its operations. I worked in the mills one winter and know my way around."

Should the farmers carry out the plan to shut down the steel mills? Why or why not?

Factories Can Alter The Weather

DISCUSSION QUESTIONS:

- Do the farmers have the right to protect their property? Why or why not?
- It is against the law to trespass and damage property. In this case is it right for the farmers to break the law? Is it ever right to break the law? Why or why not?
- Is it fair that the farmers should have to bear the consequences of smoke from the steelmills? Why or why not?
- Since the steelmakers are contributing to the farmers' problems, shouldn't they be responsible for the damages? Why or why not?
- If the smoke from the steelmills meet air pollution standards, can the public expect the steelmakers to do any more than that? Why or why not?
- What responsibilities do the steelmakers have to the public? To their workers?
- If the steelmills are shut down, the steelworkers, autoworkers, and tool workers would be out of work. Should this be important for the farmers to consider when making their decision? Why or why not?
- If your father were one of the farmers, what do you think he should do? Why?
- Should the farmers be punished if they are caught? Why or why not?
- Are the farmers being selfish in expecting the steelmills to shut down so they can harvest a good crop? Why or why not?
- Suppose that automobiles and electricity generating plants in a nearby large metropolitan city also added a large part of the smoke and smog particles that affect the weather in Franklin. Should the people living there also be held responsible for the farmers' plight? Why? Is there any way they can help remedy the problem?

PART B — Changing Climate — Changing Activities?

Factories, power plants and cities have been identified as contributors to the increased carbon dioxide in the air for the past century. This increase has produced what is commonly known as the "green house effect" because the carbon dioxide acts as a heat shield, preventing surface heat from escaping. As a result the temperature of the earth has risen. Some scientists have suggested that the increase amounts to as much as 11°F.

With population and industrial growth, the rate of carbon dioxide accumulation will continue to increase, accompanied by temperature rises.

Suppose that a warming trend persists and winters become shorter, summers longer. How might you be affected?

Instructions:

Fill out Student Worksheet *Changing Activities* to be distributed by your teacher.

Consider how your activities might be affected by a warmer climate in these two conditions: warmer and wetter and warmer and drier. Assume that the average increase in temperature will be 10°F. For the drier condition assume that rainfall will decrease by 20%. For the wetter condition assume that rainfall will increase 20%.

A sample of a similar type of analysis by a professor in sociology is found in Table 2. In that analysis the effects of a cooling trend were considered. In a colder and wetter situation, longer winters and more rain and snow were expected. He then identified a series of human activities and considered how each might be affected by the climate change. For example, he envisioned that families will be spending more time indoors, and as a result, family members will have more opportunities to do things together and come to know one another better. In terms of health care he suggested that colder weather increased the incidence of illness as well as injuries from ice and snow. Therefore, more time would be devoted to caring for the sick and injured.

In completing your analysis, try to think of the characteristics of each season in the area you reside and what you do during those times. Then try to imagine what it would be like if it were hotter with more precipitation or hotter with less precipitation.

After each person has completed the assignment, meet in small groups to compare your analysis and discuss the following questions:

Questions:

- In what categories were your analyses similar? Different?
- Did you find the change desirable?
- What activities were most greatly changed? Unchanged?
- What changes might you find most difficult to adjust to?

Write a summary statement based on the group's input for each of the two situations. Include the group's likes and dislikes regarding the change and how people will have to adjust to the change.

A spokesperson from each group will report the group's conclusion at the class meeting.

TABLE 2.

Outline of Anticipated Changes in Family and Community Activity Due to Two Types of Climatic Change

Activity	Average Weather Conditions	
	Colder and Wetter	Colder and Drier
LOCAL		
Within the nuclear family	Increased adult-child interaction Increased sibling interaction	Less significant change in same variables
Neighboring	Reduction in frequency	Minor change only
Journey to work:	Increases tardiness and absenteeism More time spent on road	No significant change
Shopping	Slight increase in time per unit purchased	No significant change
Education	More school closings Increase in unsupervised children at home Reduction in outdoor exercise for children	Minor change only
Leisure and recreation	Sharp reduction in outdoor activity (winter) Significant reduction in outdoor activity (summer) Increase in indoor, passive leisure	Slight reduction in outdoor activity (winter) Slight increase in outdoor activity (spring, summer, and fall)
Health care	For both home and hospital, increase in time spent caring for sick and injured	No significant change
Political activity	Reduced citizen participation Additional reliance on TV during political campaign	Minor change only
Other business activity	Greater day-to-day variance in volume of retail sales More frequent delays in delivery of products and services	Minor change only
Religious activity	Reduction in participation in organized activity	No significant change
DISTANT		
Familial	More interrupted and cancelled trips	No significant change
Leisure and recreation	Increase in interrupted and cancelled trips (winter) Decline in trips to certain areas (all seasons)	Minor change only
Commuting to work	Decline in number of commuters using autos	No significant change

J. Eugene Hass, "Social Impacts of Weather Modification" in Terry A. Ferrar (ed), *The Urban Costs of Climate Modification*. New York: John Wiley & Sons: 1976, p. 113. Reprinted by permission.

CHANGING ACTIVITIES

Describe how the listed activities will change if climate in your area changes.

	Hotter & Wetter	Hotter & Drier
School Class activities Sports — outdoor indoor Field trips Attendance at after school activities		
Home Family activities Activities with friends T.V. viewing Time spent indoors Chores - indoors Chores - outdoors		
Food Mealtimes Cost of food Types of food eaten		
Recreation & Entertainment Vacations Weekends Entertainment		
Clothing Types of clothes Costs		
Travel Local Long Distance		

SAMPLE: Use the worksheet distributed by your teacher
DO NOT WRITE IN THE BOOK

Reading 9

Acid Rain Fallout: Pollution And Politics

by James Gannon

The birds are back in Hyde Park. That's the good news from London in recent years, and its implications go far beyond a mere ornithological happening. The birds are a sign of London's triumph over its deadly smog, smog that killed 4,000 people in a terrifying four-day inversion twenty-five years ago. Air that can support birds can also support people — and it can help to sweep away the dark memories of the world's worst air pollution disaster.

From Scandinavia the news is bad. Acid rain and snow, a form of pollution unknown twenty-five years ago, have caused massive fish kills in the past two decades. Ironically, England is a major contributor to the Scandinavian pollution. The birds live in Hyde Park while the fish die across the North Sea in southern Norway and Sweden.

At first glance the trade-off may seem favorable to some observers — even when you count the fish kills in Canada and the United States from North American sources of pollution. No massive toll of human beings of the magnitude that London experienced in 1952 can be remotely linked to acid rain. Not even one human death.

But to a leading American authority on acid rain, Gene E. Likens of Cornell University, the fish kills are a "disaster." Likens, an ecologist, is alarmed by what he perceives to be a threat to the natural life systems.

"One has to be very seriously concerned about this kind of environmental insult on the natural system," he warned. "There is a limit to the stress they can withstand. The forests and the lands are life-support systems. Without those life-support systems to cleanse the air and the water, to provide food for us to eat, our health is just as much in jeopardy as if something is affecting us directly."

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Acid Rain Can Eventually Kill!

These are some of the signs of stress that concern Likens:

- Acid rain has wiped out commercial salmon fishing in much of southern Norway and Sweden and has destroyed sport fishing in parts of Scandinavia, eastern Canada, and the northeastern United States.
- Acidic lakes and streams do not simply kill fish; they eliminate other forms of aquatic life — including microscopic forms — and affect larger animals that feed on fish.
- In waters where the fish are not all gone the acidity contributes to higher levels of mercury contamination in the most desirable game fish, and the contamination can be passed on to humans.
- Acid rain may leach nutrients from soils and impede the growth of vegetation, including plants for food and timber; it has done so, at least, in laboratory experiments.

Acids do occur naturally in the atmosphere and have always fallen to earth in precipitation. But nature's marvelous system of checks and balances has neutralized them — until recently. Now the excessive loading of man-made acids on vulnerable land surfaces tips the balance against nature. These acids usually originate in the burning of fossil fuel for electricity and other uses and in smelting of ores for industry.

But they don't start out as acids. Sulfur and nitrogen oxides emitted from the stacks are oxidized into the dehydrate of sulfuric and nitric acids. Water in the atmosphere does the rest. Measurements by Likens at the Hubbard Brook Experimental Forest in the White Mountains of New Hampshire confirm the acid components of rainfall to be as much as 65 percent sulfuric and 25 to 30 percent nitric. Other monitoring stations have detected these acids in slightly lesser amounts. Both are highly corrosive acids. They can destroy plant and animal cells — *destroy life* — on contact.

The rainfall is still almost all water. The acids occur only in minute amounts, never in strengths greater than the acids in the human stomach, but often — and here's the danger — in strengths greater than the acids in nature.

Acid rain can fall anywhere downwind of urban or industrial pollution. In cities it is simply one more element undermining air quality. it contributes to the corrosion of buildings and monuments and has subtle, long-term effects on human health.

But acid rain is more remarkable for transferring what has been an urban problem to the countryside. You do not expect to find the effects of air pollution in the Canadian wilderness or among the stately mountains of New England and northern New York — but you find them there now.

The pollutants come from near and far, and they travel in all directions without respect for international boundaries. A report prepared for the Canadian-American International Joint Commission shows that Lake Superior receives significant acid fallout from points as distant and scattered as St. Louis, Cincinnati, Pittsburgh, and Sudbury, Ontario.

The American Cities are all more than five hundred miles away from Lake Superior. If conditions are favorable, the pollutants can go that far in a day. They've been known to stay airborne for weeks, although Swedish scientists estimate that the average time aloft is two to four days. There's time, in any case, for pollution originating in North America to travel across thousands of miles of ocean to Sweden and Norway. it is not uncommon for acid rain that falls in Scandinavia to be "made in the U.S.A."

That's a bit startling, but it is consistent with known global transport of atomic and volcanic clouds. Tall industrial smokestacks built in the past quarter century to help clean up cities like London may account, in large measure, for long-range pollution.

The danger is growing. Acid rain is so widespread today that the average rainfall in the eastern half of the United States and southeastern Canada — regions of heavy industrialization — is about twenty-five times more acidic than it would be if the rain contained acids from natural sources only. As recently as ten years ago, that sort of acid intensity could be found only in the northeastern states and around the nickel mining center of Sudbury, Ontario. But today there are more than 200 tall stacks in the United States alone, rising 400 to 1,200 feet above power plants and smelters and spewing the sulfar and nitrogen compounds into the atmosphere. The acid rain problem could become even more

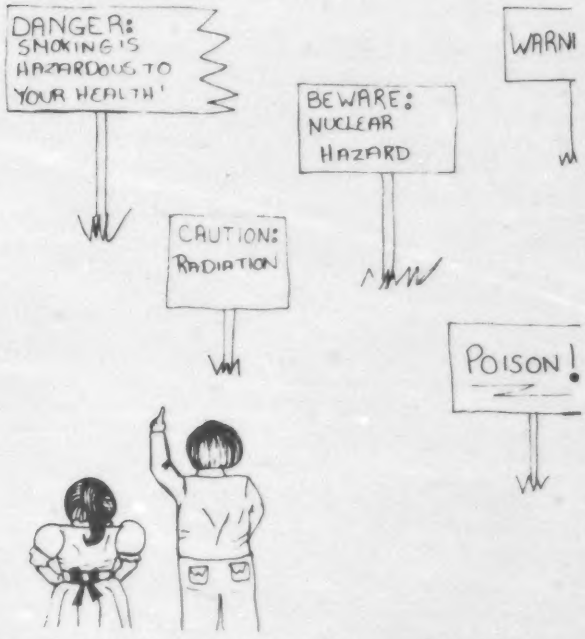
acute with construction of many more coal-generating facilities.

The administration's national energy plan, given to Congress in the fall of 1977, calls for an 80 percent increase in the use of coal for electrical generation. Under a 1977 clean air law, the best available technology will be required for new plants. Right now that means "scrubbers," devices that can trap 90 percent or more of the sulphur dioxide from a plant's flue gas. But a huge environmental battle has been brewing about the pollution controls needed to check the emissions from all these new plants. Meanwhile, there are no significant standards for nitrogen oxides — a huge part of the acid rain problem — a little research on technology to control that pollutant.

The danger from acid rain is greatest in lakes situated in hard-rock areas where the rocks and soils are low in neutralizing chemicals, such as the calcium carbonate in limestone. All soils have these "buffering" chemicals to a greater or lesser degree, but many underlying rock formations do not. Rocks made of granite or lava, for example, simply do not react with acid. So acid rain can gradually, almost imperceptibly, disrupt the surface ecosystem.

The entire Canadian Shield, made of Precambrian rock formed six hundred million to four billion years ago, is vulnerable. It stretches from the Arctic Circle across most of Greenland and the eastern half of Canada into the United States below the Great Lakes. Combined with other pockets of hard-rock formations, it adds up to more than a million square miles of acid-sensitive land surface in North America.

Lakes in hard-rock areas, said Likens, are the "clearest and most dramatic example" of acid rain's effects. An acid lake is a death trap for fish. For the newly spawned, should they survive the spawning, it is almost instant death. For older fish, more resistant to the toxic effects of acid, it is a slow and tortured death. However it comes, death is inevitable, for fish and for other forms of life, as the acid level slowly rises.



We Can All Help To Fight The Dangers Of Acid Rain

Richard J. Beamish, a scientist for Environment Canada, has probably spent as much time as anyone in North America studying what acid does to fish. For many years Beamish used the acidic lakes around Sudbury, site of the world's richest nickel deposit and the world's largest single point source of sulfur pollution, as his "laboratory."

Beamish and his colleagues found that adult fish became emaciated, stunted, and deformed under acid stress. Far more destructive for the fish populations, however, was the failure of female reproduction. "Eggs were developed," Beamish discovered, "but they were never passed from the ovary and fertilized." It made the premature deaths of adult fish a moot point, he theorized, because without the recruitment of new fish into the population, the species is inexorably reduced to zero.

That happened to one species after another in lakes that Beamish studied. Some prime game fish, small mouth bass and walleye, were the first to be eliminated. Northern pike and lake trout, were next. Even the most acid-tolerant fish, such as lake herring, perch, and rock bass, eventually succumbed to the lethal acid.

Beamish estimated — "conservatively" — that two hundred to four hundred lakes within a fifty-mile radius of the Sudbury smelters have few or no fish remaining. Since the construction of the world's tallest smokestack at Sudbury, acid pollution has reached out to Ontario's popular resort areas of Muskoka and Haliburton where the lakes are on the edge of disaster. Pollution made in the United States will undoubtedly share blame for the disaster.

In Scandinavia the problem is even more severe. Lars N. Overrein, director of comprehensive Norwegian study of acid rain, reported that the "majority of inland waters . . . have completely lost their fish populations." That runs to "thousands of localities."

In New York's Adirondack Mountains the fish are gone from about a hundred lakes and streams at higher elevations; and ecologists fear, the loss of "buffering capacity" and ultimately the loss of fish, in the lower valleys.

The spring snow melt, when acid levels can rise precipitously from winter snow accumulations, is the most dangerous time for fish. A late winter thaw in 1975 killed trout by the thousands along the Tovdal River in southern Norway.

Fish are not the only casualties. Around Sudbury the acid lakes look pure because they are so clear because, for all practical purposes, they are dead. The organic life has been virtually erased: fish, amphibians, invertebrates — all gone. Plankton, gone. Algae, bacteria, severely reduced or chemically altered. The entire aquatic ecosystem snuffed out — perhaps irrevocably. Beamish said at least one hundred lakes near Sudbury fit this description, and he doubts that they can be restored. When the chain of life is broken like this, the

higher animals are also affected. Fish-eating birds and vertebrates have left the lakes.

Parts of the barren landscape around Sudbury will resemble what the earth will be like when life is gone entirely. The vegetation has been destroyed by the direct fallout of sulfur dioxide. But twenty-five miles away the land looks normal — at least to the untrained eye.

It's difficult to tell what happens to forests and agriculture from acid rain. So many hazards — fungus, insects, bacteria, drought, and other man-made pollutants — can afflict a plant in the natural environment that sulfur dioxide and acid rain are merely additions to a long list. But scientists have clearly shown in laboratory experiments that simulated acid rain, with other negative influences factored out, is destructive to vegetation.

Acid rain has a capacity to "leach out" nutrients that can affect the environment in different ways. Falling directly on plants, it causes leaf lesions, reducing the area for photosynthesis and limiting growth. In the soil it impedes root development.

Swedish scientists predict that acid rain will leach calcium from their nutrient-poor woodland soil, leading to a reduction of forest growth of 10 to 15 percent by the year 2000. If true, that will be a serious economic loss. (The Canadian and American pulp and logging industries, notorious denuders of the landscape, should take note.)

The leaching property of acid rain also draws out heavy metals from the earth and atmosphere. Metals such as aluminum, mercury, lead, cadmium, tin, beryllium, and nickel are drawn into the freshwater systems and held in solution by the acid.

One result is another mechanism of fish mortality, this one discovered by Carl L. Schofield, a Cornell biologist, from observations in the Adirondacks. In this case, aluminum combined with nitric acid is the deadly weapon. "We found," said Schofield, "that the aluminum in this situation is very toxic to fish. You get a much higher toxicity for a given level of [acid] than you would otherwise."

Mercury is one of the better known threats to human health. The human race has had quite enough experience with it to hold it in respectful fear. It kills or maims in any form. As methyl mercury, one of its organic forms, it accumulates in fish — a major source of protein for humans.

The worst outbreak of mercury poisoning from fish occurred in the 1950s in Minamata, Japan. More than one hundred people died, and several hundred others suffered symptoms ranging from mild tingling of the skin to reduced motor coordination, retardation, and impaired sight and hearing — effects that are permanent because mercury causes irreversible damage to the cells of the central nervous system

That tragedy came from the industrial discharge of mercury waste into Minamata Bay, where it contaminated fish and shellfish eaten by local people. Industrial dumping of mercury into Ontario's English/Wabigoon River system and other freshwaters of North America has brought fear and consternation closer to home, es-

Mercury — Deadly To Fish And To Humans

pecially among native populations who make a steady diet of fish.

The "acid connection" to the mercury contamination of fish is more subtle. It occurs in the same waters vulnerable to human-generated acid pollution: softwater lakes situated on hard rock strata. Mercury enters the water in a metallic inorganic state, then falls to the bottom sediment where it is converted by microorganisms to an organic form, methyl mercury. Methyl mercury passes easily into the food chain and, because it does not pass easily out, accumulates in fish regularly eaten by humans.

A Swedish scientist, Arne Jernelov, has established a clear correlation between the acid levels of lakes and mercury levels of fish — that is, the more acid added to a lake's water, the more mercury in its fish, up to the point where the acid kills the fish outright.

More than 600,000 U.S. citizens go fishing in Ontario each year. Increasingly, they are fishing in troubled waters. They can find out for themselves by writing to Ontario's Ministry of the Environment (the tourist industry won't tell them) for the "Guide to Eating Ontario Sport Fish." Excluding the Great Lakes, 336 lakes and rivers (70 percent of 479 cited) have at least some contaminated fish at levels officially considered unsafe for prolonged human consumption. The highest levels were found in the predator game fish, walleye and northern pike.

But sport fishermen have no cause for alarm, according to John M. Wood, director of the University of Minnesota's Freshwater Biological Institute. "They don't get sufficient exposure to mercury-contaminated fish to really seriously be threatened. You have to have a diet of fish for a significant period of time to be affected."

Like the diet of the Canadian Indians, for example. They eat fish almost daily in the summer, and they have cause for alarm. In a recent survey by Health and Welfare Canada, 42 percent of 764 Indians tested in Quebec, Ontario, and the Northwest Territories had abnormally elevated blood or hair mercury levels.

It's the Indians trying to live close to nature who are most immediately threatened by acid rain. The threat is magnified at the tiny Ojibway Village on Lac La Croix by the prospect of an 800-megawatt power plant close to home.

Chief Steve Jourdain wants to keep the ways of his ancestors, but he doesn't mind enjoying the benefits of modern industry. When he clears his beaver traps in winter, he makes the rounds by "ski-doo" (skimobile.) Two years ago, he said, his band of two hundred "kicked out" welfare because it "goes against our belief that welfare is a damaging thing."

Now they are trying to live off the wilderness, fishing, hunting, and trapping. Their only outside source of income comes from guiding U.S fishermen in the summer, and they pick up a few extra dollars from the declining number of pelts they gather in the winter. The thought of acid rain has them virtually paralyzed with fear.

Lac La Croix, a softwater lake on the hard-rock Canadian Shield, rests directly on the Canadian-American border. It's adjacent to two wilderness preserves: the Boundary Waters Canoe Area, an official "national wilderness area" in Minnesota, and the Quetico Provincial Park, a "primitive wilderness" in Ontario.

The Indians live on the Canadian side, and their own provincial government is about to execute the final blow to their tenuous wilderness existence. Ontario Hydro, a crown corporation, plans to build a large coal-fired power plant near Atikokan, only fifty miles from the village. That's why they're afraid; visions of Sudbury keep coming to mind. (To be wholly accurate, Atikokan would not come close to Sudbury in emissions.)

"The economic base of our reservation is the surrounding environment. If that's destroyed, our whole economic base is destroyed," says Chief Jourdain.

He could as easily fear for the present. Things are bad enough without the power plant, just from the effects of a small nearby smelter combined with long-range pollution. A simple test (not scientifically valid) has indicated that already the acid level of the lake is critical for fish survival, and one fish analyzed for mercury was contaminated.

It is hard to see how the new power plant can do other than make it worse. The utility has said it will use low-sulfur coal and claims it will not need expensive scrubbers for sulfur removal. In contrast to the United States, scrubbers are not in use in Canada, but pressure for them may increase with an acceleration in Canadian development. Environmentalists, fearing for the entire surrounding wilderness, have turned the issue into an international controversy that has reached diplomatic levels.

The Atikokan dispute illustrates as well as any one incident can the seeming inflexibility of acid rain politics. Scientists are concerned about the plant's effects but in the absence of a four-star disaster like the London inversion, the kind that inspires mass demand for reform, industries and governments are likely to remain unmoved. It seems Indians cannot even match the political clout of the Tennessee snail darter.

Whether industry and government are one and the same, as with Ontario Hydro, or separate seems irrelevant. Government agencies, said Frank D'Itri of Michigan State University, who headed a mercury study for the National Academy of Sciences, are "usually useless in solving pollution problems." They act occasionally after the fact to compensate victims, but almost never for prevention.

Yet government agencies spend the taxpayers' money as if their existence depended on it — and perhaps it does. The money, said D'Itri, goes into research for what he calls "technicological counter-measures." Precisely that phenomenon today threatens to turn acid rain research into a government-funded growth industry. Projects for liming acid lakes (giant Alka Seltzers) and for developing acid-resistant fish are being undertaken in lieu of any meaningful solution.

Because the use of fossil fuels is the source of the acid rain problem, the obvious solution is to stop using fossil fuels. As utopian as it may sound to those of us accustomed to seeing the world through industrial smoke, that solution is not only plausible; it is inevitable. Fossil fuel reserves will be exhausted, according to current estimates, in about 200 years.

While we bend to the task of finding alternative sources of energy, it matters how we use the remaining fossil fuels — the speed and magnitude of consumption, for example, and whether we extract the sulfur or trap the nitrogen. And it matters how fast we find safe alternatives. Because we have no choice about finding alternatives, why not act sooner rather than later, save what's left of the wilderness, and safeguard our health?

Reading 10

Pollution Parley

By Gail Robinson

Water Unfit For Fish

We are, of course, at peace. Yet within 20 years the United States may help destroy almost 50,000 Canadian lakes. And a planned Canadian project will pose a very real threat to one of the United States' most cherished wilderness areas.

The war is not intentional, nor are its weapons bullets or bombs. The U.S. and Canada are lobbing sulfur and nitrogen oxides across the border and these gases eventually return to the earth as acid rain. Now the two nations are trying to declare a truce, but, as in any treaty talks, the negotiations promise to be long and complicated.

The acid rain discussions between the U.S. and Canada began in 1978, and last July the countries issued a joint statement announcing that they agreed on such things as the exchange of scientific information on air quality and the reduction of "transboundary" pollution.

In the case of acid rain, most of the "transboundary" pollutants come from coal fired plants, although other fossil fuel plants, automobiles and nitrogenous fertilizers, as well as volcanoes, are also sources. In the atmosphere a chemical reaction converts the sulfur dioxide and the nitrogen oxide into sulfuric acid and nitric acid and then finally, as water droplets fall from the atmosphere, into acid rain.

Before the industrial revolution, rain was virtually neutral — neither acid nor alkaline. Today, according to a recent study published in *Scientific American,* rain and snow in much of the world is five to 30 times more acidic than it would be in an unpolluted atmosphere, and individual storms can be thousands of times more acidic than they should be. A 1974 storm in Scotland was so acidic it was literally as though vinegar were falling from the sky.

Acid rain was observed in England in the 1880s. As early as the 1940s it was killing fish in Scandinavia, and it has now spread to much of northern and central Europe.

Reprinted by permission from *Environmental Action,* November 1979 © 1979 Environmental Action, 1346 Connecticut Ave., NW, Washington, D.C

In the United States, acid rain has ravaged much of upstate New York's Adirondack Mountains and has spread over most of the Northeast. Sharp increases in the acidity of precipitation have also been reported in the Southeast. The most recent studies show that acid rain is now threatening the Rockies.

Buildings are eroded by acidic downpours and crops can be adversely affected. Scandinavian experts say it could cause a 15 percent drop in timber yield within the next 20 years. But acid rain has perhaps its most lethal effects on lakes, which simply cannot neutralize the acid. And, according to a Brookhaven National Lab scientist, when a lake gets very acidic, the water can leach mercury, lead and aluminum from the atmosphere, and aluminum, for one, can melt a fish's gills.

As *Field and Stream* observed in a recent article, lakes afflicted with acid rain can look absolutely wonderful — clear depths sparkling in the sun. But beneath that pastoral exterior, lurks a dead or dying lake; in the Adirondacks 56 percent of the lakes above 2,000 feet are barren; approximately 140 lakes in Ontario are dead or nearly dead; and seven Nova Scotia rivers, once teeming with salmon, are now devoid of the popular fish.

But while the effects of acid rain are readily apparent, people have been slow to discover its cause, finding it hard to believe that in the Adirondacks fish are dying from pollution. Pollutants, though, can blow long distances. And the situation is often exacerbated in mountainous areas, where the pollution is trapped until frequent rains wash them out of the sky — and down to earth.

The Clean Air Act contains two major methods of combating air pollution. One requires that air in a given area not exceed a specific clean air standard and the other — the so called new source performance standards — dictates that all new sources of pollution must also conform to certain standards. But a report in *Science* magazine predicts that sulfur emissions will still increase by nearly 2 million tons over the next 15 years because coal burning is expected to increase sharply and because standards for existing plants are lax.

Faced with acid rain, New York State has taken an "if you can't beat 'em, join 'em" approach — dumping lime in Adirondack lakes to neutralize the acid and encouraging development of acid resistance strains of fish. But as the U.S. plans to increase its reliance on coal, the need for real solutions to the acid rain problem becomes ever more pressing. Scrubbers can be installed on existing plants in addition to the new ones, coal can be washed, utilities could be required to use their newer, cleaner plants whenever possible (for base instead of peak load) and, of course, we can simply use less energy. But when asked whether the government might try to clean up existing plants, a government official said, "Given the economic situation and the energy situation, it will be very difficult."

Canadian law is also far from perfect. While the national government has set ambient air quality standards, the responsibility for enforcement and implementation lies with the provinces. According to Ron Reid, staff environmentalist for the Federation of Ontario Naturalists, a provincial group with 60 member organizations, "In general, it [Canada's clean air law] is reasonably effective. The weakness comes in that it has a fair amount of flexibility, so when it's being implemented, it's easy to make tradeoffs."

And its precisely one of those tradeoffs that got Americans upset about Canadian emissions. Ontario Hydro is planning a 400 megawatt coal fired plant at Atikokan, 38 miles from the wilderness Boundary Waters Canoe Area; it will not have scrubbers.

For the most part, though, it is Canada that feels victimized by the United States, whose industrial centers emit 30 million metric tons of sulfur dioxide a year, about four times what Canada emits. (The world's largest producer of sulfur emissions, however, is a Sudbury, Ont. metal smelter.) The Canadian government estimates that some 50 percent of Canada's acid rain is caused by Americans. On a recent trip to Washington, Canadian environment minister John Fraser told reporters that the U.S. sends Canada about 4 million tons of sulfur dioxide a year, while Canada sends less than 1.4 million tons our way.

"It works both ways," Fraser was quoted as saying. "We are not coming down here wringing our hands saying you're the culprit. We've got a joint responsibility.

While sympathetic to the Ottawa government's interest in negotiating an acid rain treaty, Reid comments, "We believe we should be cleaning up our own backyard. The temptation is very great politically to point the finger at someone else."

The U.S. government has also given signs of wanting to do something about acid rain, though it too is not above reproach. In his environmental message last summer, President Carter announced the formation of an acid rain program, which would monitor acid rain and allow various agencies and departments — including the State Department, which is handling the treaty negotiations — to share ideas. While this pleases environmentalists, Betsy Agle, project coordinator for the Clean Air Action Coalition, commented on the conflicts in Carter administration policy: "It's contradictory to have an energy mobilization board and to do a massive acid rain initiative."

Much of the information gathered by the assessment may seem old hat. But Agle says, "If you're going to ask people to pay substantial costs for controlling something, you're going to have to say what that can do." According to Agle there is some talk that it will cost $5 to $7 billion to cut sulfur dioxide emissions by 50 percent in the northeast, and $350 million to do the same thing in eastern Canada.

Faced with such high cost estimates and with the energy situation, the negotiations between the U.S. and Canada have now entered the difficult stage. The two sides must try to agree on specifics — specifics which environmentalists hope will include a plan of action rather than merely a joint research commitment. According to the U.S. government official working on acid rain, the negotiations are particularly difficult "because we have totally different systems on each side. Here we have federal control. In Canada, they do not."

"The Canadian objective," he noted, "is to cut down on pollution coming from the U.S. They don't believe the new source performance standards will solve the problem."

While there are obvious difficulties, they may not be insurmountable. Early in the century, the two governments agreed to keep the boundary waters clean and in 1978 they signed an agreement on water quality in the Great Lakes. There are also international water quality agreements in Europe, and while air is more ticklish to deal with — the U.S. and Canada have never negotiated an air treaty before — European nations are also working to hammer out an accord on acid rain and have already agreed to monitor air.

Throughout the process, the government will be watched by environmentalists. Twenty-five environmental groups will meet at a conference organized by Agle in Toronto on Nov. 1, 2 and 3 to draw up a plan of action. The groups hope their meeting will lead to greater awareness of the acid rain problem, to a discussion of possible political and legal solutions and to the formation of an international citizens network.

It's easy, of course, to be cynical about the treaty talks. How can the Carter administration expect anything from Canada when the U.S. is gutting its own environmental regulations? What right has Canada to get uppity when it still builds coal fired plants without scrubbers? But something clearly has to be done to clean up our air and our lakes. And the U.S.-Canada talks are at least an acknowledgement of the fact that the poisons in our atmosphere know no national boundaries.

Dilemma 4 — THE ACID LAKE AND JOBS

The trout in Lake Lawson, the state's prime fishing area, were diminishing at an alarming rate, according to the latest park survey. The decline in the fish population was traced to the increased acid content of the water, which affects the fish's ability to reproduce. This report gave Governor Jones great cause for alarm, because it meant that an important and scenic area was threatened! The culprits, he knew, were the glass making companies and electricity generating plant located 50 miles west of the park. The plants burn the less expensive high sulfur content coal which emit large quantities of sulfur dioxide. Winds carry the particles eastward which in turn mixes with rain water and forms sulfuric acid. This "acid" rain then falls over the park forest and empties into the lake.

However, the companies had been issued special permits allowing them to burn the high sulfur coal. Despite their use of this type of coal, the state's air quality met the rigorous standards set up by the federal government. If the glass companies were not permitted to use the less expensive coal, they would be forced to close down. Over 20,000 workers would lose their jobs. Since glass making happens to be an important industry to the state, shutting operations would be a severe blow to the state's economy. Without the glass companies, the entire western section of the state might suddenly become a depressed area. If the electric power plant had to switch to the higher priced coal, it would have to charge its customers more for electricity. With the cost of everything being so high already, the residents of that area would have a hard time making ends meet.

Should Governor Jones order the companies to burn low sulfur coal? Or should he allow them to continue to burn high sulfur coal?

DISCUSSION QUESTIONS

- What responsibilities does the governor have to the people of his state? Why? To the parklands and wildlife? Why?
- What should be the governor's main concern? Why?
- Should the protection of natural areas and recreational activities be an important consideration? Why or why not?
- From the perspective of the glass workers what action should the governor take, if any? Why?
- Should people have the right to expect good recreational areas? Why or why not?
- In addition to recreation how might the increase of acid rain be detrimental to the wilderness park area? To the state and its people as a whole?
- Would the governor be treating the glass companies and its workers unfairly if the special permits are withdrawn? Why or why not?
- Is there any way that the glass workers' jobs can be protected?

PART C — An Evaluation of Possible Effects

- Meet in small groups of 3 to 5 students to briefly discuss the dilemma, "Acid Rain and Jobs." Consider some of the "Discussion Questions" in your analysis of the situation.

- Your teacher will distribute Student Handout 2, "An Evaluation of Possible Effects." (See sample on the next page.) On the worksheet, list some of the possible consequences of Governor Jones' decision. If he continues to permit the use of high sulfur coals, the soil and water in the park would become more acid. If he withdraws the permit, the glass companies would close and the cost of electricity would increase.

- List the consequences/effects in both the immediate and future categories.

- According to your opinion, how harmful is each effect? Indicate the level of severity with a number from 1 to 4 in the "Harm" column.

  4 = most harmful
  3 = very harmful
  2 = somewhat harmful
  1 = least harmful

- Review the readings for additional information to help you complete the worksheet. You may also wish to consider some of the consequences of strip mining low sulfur content coal.

- This worksheet may be completed individually or with your group members. If the worksheet is done individually, each person will present his/her analysis to the group for discussion. The findings are then combined to produce a group report.

- From the results select 1) what the group believes are two of the most harmful effects from a short term perspective; and 2) what the group believes are two of the most harmful effects from a long term perspective. List these for the class to examine.

- After examining the consequences with the entire class, try to reach a consensus as to what Governor Jones should do. What are the best reasons for supporting this decision?

AN EVALUATION OF POSSIBLE EFFECTS

THE SOIL AND WATER IN PARKLANDS BECOME MORE ACID

Immediate Consequences	Harm	Future Consequences	Harm
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	

THE GLASS COMPANIES CLOSE DOWN, AND POWER PLANTS BURN LOW SULFUR & COAL

Immediate Consequences	Harm	Future Consequences	Harm
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	

SAMPLE: Use the worksheet distributed by your teacher
DO NOT WRITE IN THE BOOK

Reading 11

The Desert Made By Man

by Salah Galal

It comes as no surprise in Egypt to hear that the 1977 State of the World Environment Report predicts a halving of the area of cultivated land per person by the year 2000. Egypt has already seen it happen once. The area of cultivated land per head has dwindled from 0.39 feddan (approximately the same number of acres) per head in 1930 to 0.1 today, a fall of more than 50 percent.

Population increase has of course played an important part. The past twenty-five years have seen the number of Egyptians rise from about 20 million to 38 million, and the next twenty-five years will see it rise again to about 70 million.

But the loss of the land itself is also important. Although 919,000 feddan of land were reclaimed during Egypt's first two five-year plans, more than 600,000 feddan have been lost in the same period to industrial and urban sprawl alone. Just to maintain the area of cultivated land per person at present levels means reclaiming at least 150,000 feddan each year. But in practice land reclamation has almost come to a standstill.

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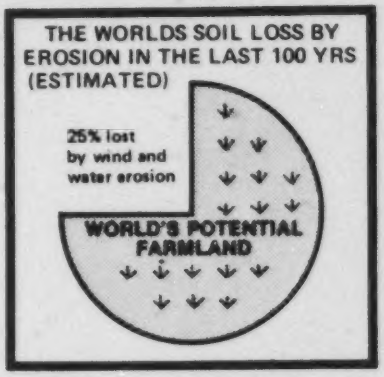
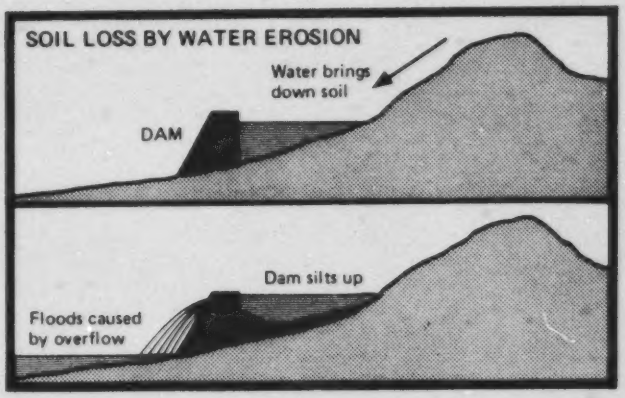
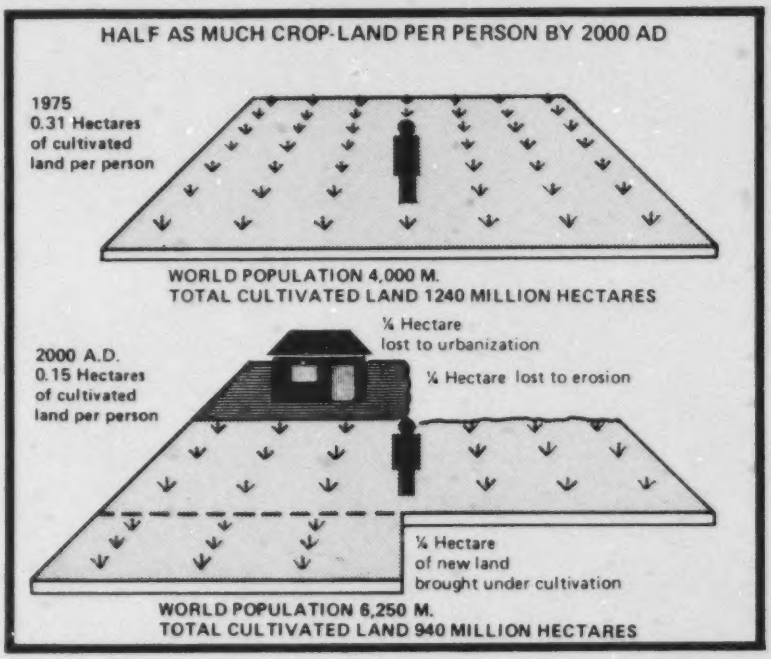
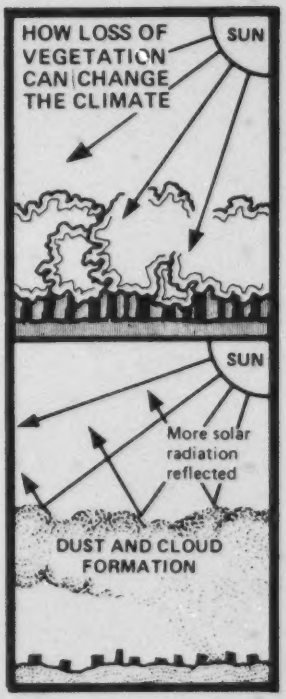
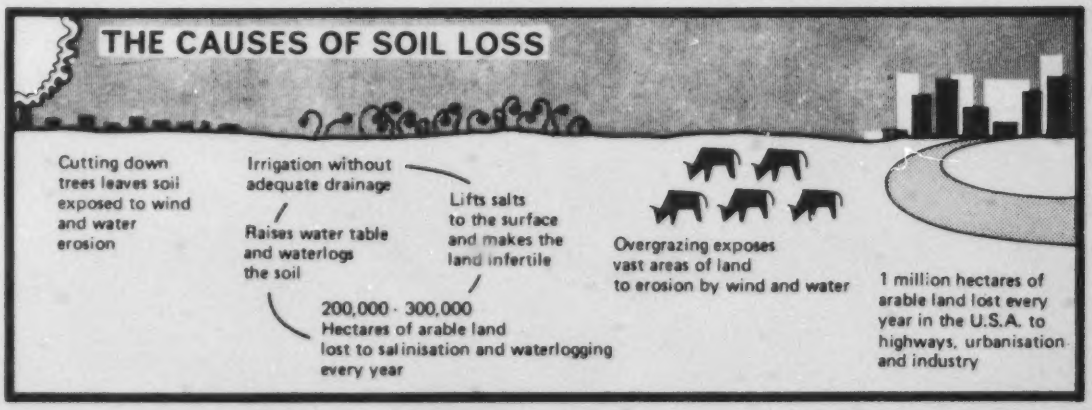
Losing Ground


THE WORLDS SOIL LOSS BY EROSION IN THE LAST 100 YRS (ESTIMATED)
25% lost by wind and water erosion
WORLD'S POTENTIAL FARMLAND




HALF AS MUCH CROP-LAND PER PERSON BY 2000 AD
1975
0.31 Hectares of cultivated land per person
WORLD POPULATION 4,000 M.
TOTAL CULTIVATED LAND 1240 MILLION HECTARES
2000 A.D.
0.15 Hectares of cultivated land per person
¼ Hectare lost to urbanization
¼ Hectare lost to erosion
¼ Hectare of new land brought under cultivation
WORLD POPULATION 6,250 M.
TOTAL CULTIVATED LAND 940 MILLION HECTARES




THE CAUSES OF SOIL LOSS
Cutting down trees leaves soil exposed to wind and water erosion
Irrigation without adequate drainage
Raises water table and waterlogs the soil
Lifts salts to the surface and makes the land infertile
200,000 - 300,000 Hectares of arable land lost to salinisation and waterlogging every year
Overgrazing exposes vast areas of land to erosion by wind and water
1 million hectares of arable land lost every year in the U.S.A. to highways, urbanisation and industry

PETER SULLIVAN, SUNDAY TIMES [LONDON]

Although the control of the Lower Nile, delivered into Egyptian hands by the construction of the Aswan High Dam, has not led to the significant agricultural expansion on which Egypt counted, the loss of arable land to construction and the encroachment of the desert continues to narrow the agricultural base on which the progress of Egypt so heavily depends. The area between Alexandria and the Libyan border, for example, used to be the well-populated and prosperous vineyard of Ancient Rome. Today it is a desert.

Every year, in North Africa as a whole, at least 100,000 hectares of land (247,000 acres) are lost to "desert-creep." South of Khartoum, the acacia scrub zone has marched 90 kilometers (56 miles) southward in the past twenty years.

The precise causes of "desert-creep" are complex and insufficiently understood. Sometimes it is a by-product of progress. In the Kordofan Providence of the Sudan, for example, where seven hundred wells have been sunk since the mid-1950s, medical and social services provided around the well sites have concentrated the formerly nomadic populations and considerably reduced their death rates. The resulting population increase has been more than matched by the increase in the number of cattle; in the Arab lands as a whole the increase in human population is running at 2.5 percent a year whilst the number of goats, sheep, cattle, and camels is increasing at 2.9 percent a year. The result of this animal population explosion is overgrazing and the trampling of vegetation, which leaves the soil open to erosion and paves the way for the advance of the desert. In addition, mechanization of farming has uprooted trees and shrubs, and irrigation of sorghum fields has sluiced away water, leaving the soils brittle and exposed.

As desert conditions spread, so do the crop yields fall. In Kordofan the area planted with sesame increased sevenfold from 47,000 to 327,00 hectares (116,090 to 807,690 acres) in the twelve years from 1961 to 1973. But the actual production of sesame has not even doubled, and yield per hectare has dropped by 70 percent from 0.91 to 0.21 tonnes (1.0 to .23 tons). Groundnuts tell the same story: although the crop area has increased fourfold, production has actually fallen.

As the land deteriorates and the yields decrease, the herders and cultivators shift farther south, and the cycle begins again. Desert creeps into steppe, steppe into savannah, and savannah into forest. By this process, the trees have retreated before the march of the desert.

The problem is not confined to North Africa. Professor Mohamed Kassas of the University of Cairo estimates that the area of manmade desert worldwide is now more than 900 million square kilometers (360 million square miles) of once arable land. As the area of land available for cultivation today is not more than 30 million square kilometers (12 million square miles), 40 percent of the world's arable land has been lost to desert.

This stealthy march of the deserts went almost unnoticed until 1967-72, when drought struck at the countries on the southern fringe of the Sahara. As the long hot years passed with no sign of rain, fears grew that the drought was not a freak but a sign that the Sahara itself was advancing southward.

The worst fears were confirmed: between 100,000 and 250,000 people died and 2 million nomads lost half their livestock. The advance of the deserts — which now cover 36 percent of the world's land surface and contain 628 million people — suddenly became news.

The United Nations reacted by calling a World Conference on the issue for August 29, 1977, and asking the U.N. Environmental Programme (UNEP) to "assess available data on desertification." So little was known about the subject that the small team preparing for the U.N. Conference on Desertification led by UNEP's Executive Director Mostafa Tolba, virtually had to create a new science of "desertology."

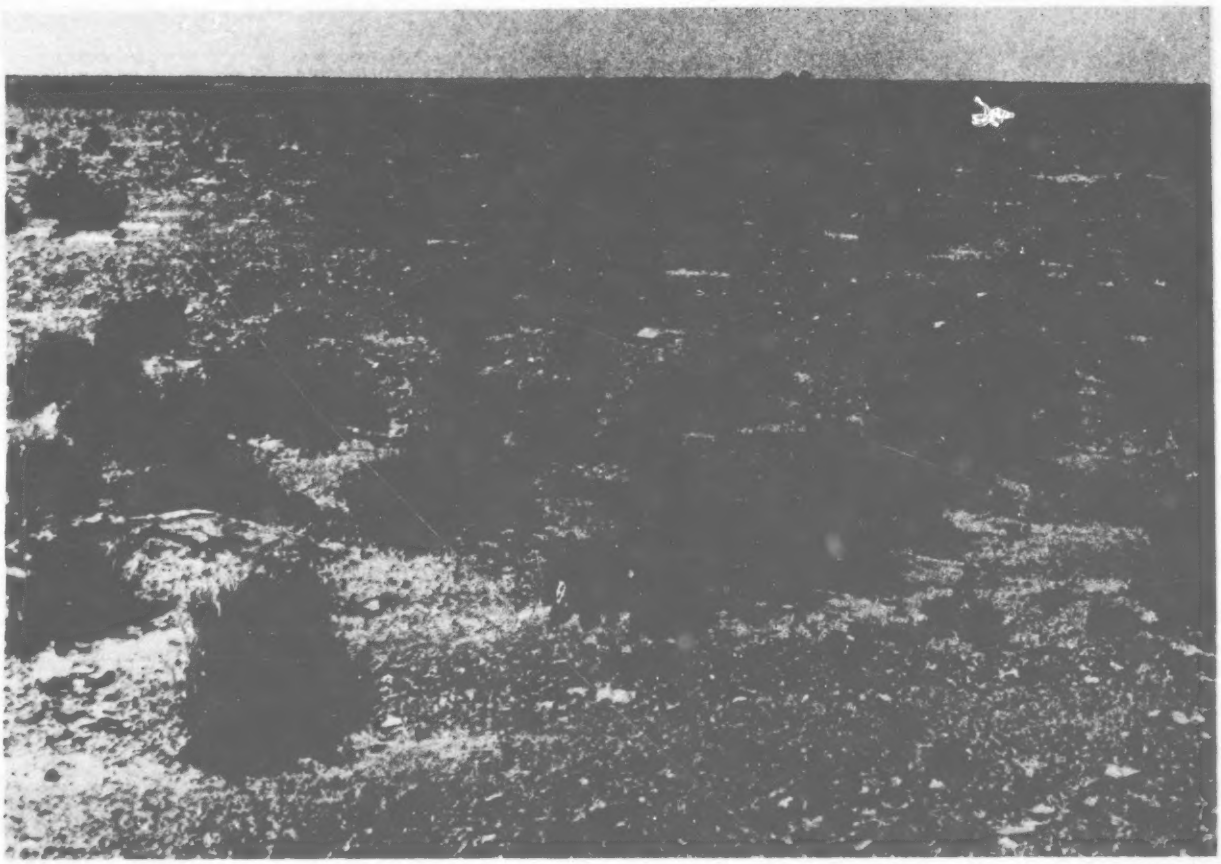
Much has already been learned. Overgrazing and trampling, slash, and burn agriculture, and firewood cutting; industrialization and construction; mechanization and excessive ploughing; land-tenure systems and water rights; feeding habits and kinship patterns; population growth; and the settling of nomads — all these factors play a part in the complex interaction between development and desertification. But the common factor in the pattern is the hand of man.

Nowhere is the pattern more clearly visible than in Egypt. Here in the Mariut area, the vines that once inspired the lyrics of Virgil have withered into the Western Desert. Yet only 60 kilometers (37 miles) to the east lie the irrigated croplands of the Nile. Impoverished desert and lush delta, both are equally man-made.

Reading 12

Sahelian Drought[1]

by Stephen H. Schneider and Lynn Mesiron



The Expanding Desert

[1]This excerpted selection is reprinted from *The Genesis Strategy*, with permission from Plenum Publishing Col., 1977.

Sahelian Drought: The Desert Advances

Perhaps the most dramatic examples of the continuing influence of the weather on human welfare are the recent situations in Africa and India. On both continents the stress of drought, coupled with large populations occupying relatively fragile, highly variable environments, has been disastrous.

In the drought-prone area bordering the southern fringe of the Sahara Desert, known as the Sahel, human populations had increased by a third over the previous thirty-five years, and livestock numbers doubled. This rapid growth has been possible mainly because of Western intervention in the economic, political, and social practices of the Sahelian nomads and sedentary farmers. In recent years the nomads have experienced the breakdown of their traditional way of life — a life that Nicholas Wade, a writer for *Science* magazine, has called "a remarkably efficient adaptation to the semidesert environment."

A major part of the Western influence in this region has been technological: medical and mechanical. The latter came partially in the form of deep water wells, designed to encourage the proliferation of the nomads' herds.

The growing herds of cows, donkeys, camels, and goats trampled the ground as they traveled from well to well, eating everything in their path. With continued overgrazing, trampling, and a lasting drought, vegetation became scarce, and the animals were forced to compete more intensely for the remaining bit of forage. They, especially the goats, desperately tore up the indigenous plants by their roots, destroying the ability of much of the vegetation to reproduce itself.

At the same time, the increase in the human population led to even more Sahelians farming still more land. In addition, the best lands were often used to raise cotton and peanut crops for foreign markets, and the farmers began to cultivate increasing amounts of marginal (ecologically fragile) lands to feed the growing local populations. Traditionally, the Sahelian farmers had wisely given their marginal lands fifteen- to twenty-year fallow periods, but recently they began to allow the land a meager one to five years of rest. By disregarding the proven grazing and farming techniques of their ancestors, the Sahelian peoples were helping to bring about desertification, a process that would make much of the Sahel a wasteland.

Desertification is extremely difficult, but not impossible, to reverse. Its first signs are a slow loss of fertility in the soil, which is followed by a rapid degradation process. The soil eventually loses its structure and becomes unable to hold sufficient moisture or vegetation.

As the desert moved southward, so did the people and livestock, stressing the retreating fringe more and more, creating further denudation and deforestation, and perhaps creating a self-reinforcing process. And so the degradation of the social and ecological systems of the Sahel continued until they finally collapsed, along with the starving humans and animals whose swollen bellies contained only water from the wells drilled by Western technology. By the late 1960s desertification had set in, and with no end of the drought in sight, a major international effort was required to keep millions of Sahelians alive. The first large-scale public awareness that a food crisis had begun thus actually arose only several years after the Sahel had, in fact, been devastated. It is reasonable that climate variations were not solely responsible for the disaster. Clearly, thoughtless applications of technology and poorly examined social and economic priorities must also be deeply implicated.

The nomadic survivors are suffering not only from physical hardship, but also from the shock of having to give up their traditional way of life. Until Western technological and economic ways were bestowed on them, these peoples lived as their ancestors did. They and their herds followed the rains, even across political borders. Now some of the survivors live a humiliating, parasitic existence in refugee camps, robbed of their herds, their possessions, and their traditions. The governments of the drought-stricken nations usually want them to assimilate and adopt the life of the modern African, often only for the reason that nomadic ways do not easily adjust to taxation, census, and government controls. "Properly run, the Sahel should be able to raise enough beef on the hoof for half this hungry continent," says writer Claire Sterling. "Yet after almost fifteen years of bountiful international aid and more than bountiful advice, the Sahel is closer than ever to becoming a wasteland."

Although it is true that normal rains at last returned to the Sahel in 1974 and 1975, the happy future of the region is by no means assured. Political scientist Michael Glantz, who is engaged in a multidisciplinary study of the Sahelian drought, has referred to the return of the rains as "The Paradox of Good News," pointing out that even worse suffering will accompany future droughts if the Sahelian peoples return to their "normal" ways now that good rain years have come for awhile. Land management of this fragile ecosystem and stringent population control of both animals and humans must be practiced, Glantz argues, if the ugly spectacle of the recent drought is not to repeat itself on an even grander scale when the next drought period begins and provide a regional example of Boulding's Utterly Dismal Theorem.

Similarly destructive processes of desertification, which are probably caused by a combination of human and natural factors, have also been occurring in India, Chile, Peru, and in southern Africa.

In India desertification is only one contributing cause of that nation's serious food problem. Thus, in the state of Rajasthan, population pressure and drought on a fringe of the Thar Desert is destroying thirty ;thousand cultivable acres each year and has already taken half of the state's area.

According to Robert R. Brooks in an article in the *Saturday Review*,

> A classic illustration of large-scale destruction is afforded by the spectacle of wind erosion in Rajasthan. Overgrazing by goats destroys the desert plants which might otherwise hold the soil in place. Goatherds equipped with sickles attached to 20-foot poles strip the leaves off trees to float downward into the waiting mouths of famished goats and sheep. The trees die and the soil blows away two hundred miles to New Delhi, where it comes to rest in the lungs of its inhabitants and on the shiny cars of foreign diplomats. . . .

Some Theories on the Sahelian Drought Disaster

A final example of how overgrazing can change the brightness and perhaps the climate of an area is the case of the Sahel, where a 1973 ERTS satellite photo of the drought-devastated land revealed the remarkable presence of a geometric, darkened shape (indicating that vegetation cover is heavier within the pentagonal shape than without). The existence of this area prompted an investigation, which turned up a large ranch surrounded by a fence to keep out the hungry, foraging herds of the Sahelian nomads. Even in that severe drought year, there was enough rain so that some vegetation could grow in the Sahel — as long as heavy grazing pressures were absent.

Dilemma 5 — TOO MANY ANIMALS

Herding, A Way Of Life

Teal is a small semi-desert country whose inhabitants are nomads and small farmers. Throughout the centuries, the predominately nomadic people existed at a bare subsistence level. Their lives depended upon herding cattle and goats from one grazing pasture to the next. In the past two decades, new deep wells were drilled to increase water supplies. With new sources of water the herds quickly tripled. The country's population rose.

The large herds soon overgrazed the land, wearing pastures down to bare roots. The thin layer of top soil once held down by the grass blew off. Grasslands turned into useless sandy deserts. This destructive process, together with a three-year drought, created a devastating famine never before experienced. Starvation became rampant. Only with the help of international emergency relief did the death toll keep from reaching massive proportions.

When the drought ended, the government decided that it had to take new strict measures to maintain the fragile pasture lands. It could not take the chance of losing more land to desert. If pasture lands were kept healthy and population growth decreased, future droughts might take less of a toll. The government thus ordered each family to limit its herds to three cows and twelve goats. Persons disobeying the order would be executed.

The Sawa family with nine children and elderly grandparents were caught in a predicament. With twice that many animals they were just barely able to keep everyone fed and clothed. The government's edict would force them to starvation since they are not farmers and owned no land. The father of the family felt that they could not abide by the order and would simply ignore it. They would hide their extra animals when the government inspectors came around. Since they were constantly moving it would be hard for the inspectors to find and keep track of them anyway.

Should the Sawa family disobey the government's orders and keep their animals? Why or why not?

DISCUSSION QUESTIONS

- Is the government being unfair to large families by issuing such an order? Why or why not?
- Since the government is thinking about the long term survival of the country, should it take whatever measures necessary to prevent overgrazing? Why or why not?
- By raising a larger herd, the Sawa family will be using up more than their share of the grasslands. Is this being fair to everyone else? Why or why not?
- What are the best reasons that you can give to support the Sawa family's decision? Why?
- Shouldn't the Sawa family consider what might happen to future generations in their country if overgrazing creates more deserts? Why or why not?
- Does the father of the family have the right to endanger the rest of the family by disobeying the order? Why or why not?
- If the Sawa family understood the importance of protecting the land from turning into desert, shouldn't they go along with the government's order? Why or why not?
- What should be the responsibility of a good government? Why?
- The Government realized that people would not abide by such a law if the punishment were not severe. In this case was the punishment justified? Why or why not?
- What should be the father's responsibility to his family? Why?

Dilemma 6 — A NEW THEORY

Claude Anderson, a leading scientist, presented at the annual gathering of meteorologists his new theory to explain the recent devastating drought in Atlas. Atlas is a poor semi-desert country inhabitated by sheep herding nomads. His theory was that air pollutants from factories located in the neighboring industrialized country of Natah had created a cooling effect. This effect changed the monsoon weather patterns over Atlas. Without enough rainfall, grazing lands became parched. Thus, widespread famine and death fell over the land.

Although some of the scientists felt that his theory might be correct, the others argued that the data was not conclusive. They then decided that the organization would not publish Dr. Anderson's paper. The scientists reasoned that the information would create an international incident. The government of Atlas would use the information and demand that Natah repay it for the harm and suffering its people endured. Since the two countries are always on the verge of war, the information might provide just the reason for an all out battle.

The other scientists ordered Anderson to keep quiet and not make his findings known to the press. This came as a blow to Anderson. He believed that his message was too important. All countries needed to be warned that their industrial activity can seriously change climatic conditions. "Changing climatic conditions can lead to widespread crop failures throughout the world," he claimed. "It's a forecast that could save lives, and I'd stick my neck out as far as possible to get the message across. I plan to discuss plans to stop Anderson from announcing his theory to the public.

Should the scientists carry out their plans to stop Anderson? Why or why not?

DISCUSSION QUESTIONS

- Should Anderson have the right to present his theory to the public? Why or why not?
- Should a scientist present his/her discoveries even if the information might be used to start a war? Why or why not?
- It is possible that Anderson's theory might be incorrect? Should that be reason enough to stop him? Why or why not?
- Should Anderson be concerned about what his fellow scientists think of him? Why or why not?
- What responsibilities do scientists have towards the general public? Why?
- Should scientists be the ones to decide what the general public should or should not know? Why?
- How important is "freedom of speech" in this situation? Why?
- If you were in Anderson's place, what would you do? Why?
- Who should be blamed if a war were started? Why? Can scientists be held responsible for their discoveries?

Reading 13

Natural Disasters: The Human Hand[1]

by Lester R. Brown

When under stress, natural systems become highly susceptible to injury. Then minor or routine events can become major catastrophes. Moderate floods of a seasonal nature can assume calamitous proportions and devastate human life, crops, and livestock. A drought that would normally be a hardship becomes a disaster. A minor earthquake can leave the local economy in ruins.

One case study of the human contribution to natural disasters was undertaken by Kenneth Hewitt, who describes the extensive damage a relatively minor earthquake of 5.5 on the Richter scale caused in the mountains of northeast Pakistan. According to Hewitt, earthquake damage was far greater in deforested areas. The rockfalls and landslides that followed the quake did as much harm as the quake itself: "Farms and villages in the steep-walled tributary valleys and narrows of the Indus suffered mainly from the terrible rain of boulders following the tremors. The results were more like bomb damage. Landslides were also a major factor in the destruction of irrigation channels and terraces here." Not only is the damage worse, but it is often irreversible, as Hewitt emphasizes: "Moreover, landslides are a particularly bad way for terracing to go. The entire solid element is swept away, sometimes directly into a streambed and downstream before it can be recovered. It probably ended up in Tarbela Dam, a huge irrigation and power project some 120 kilometers down the Indus. Since sedimentation is the major problem in the economic lifetime of the reservoir, agricultural productivity was thus diminished at both ends."

Increasingly, "natural" catastrophes are brought on at least in part by humans. Even when disasters are not triggered by human activities, they can be exacerbated by them. As Hewitt says, "the number of natural disasters and the degree of damage in general have increased in this century," and since "there is no reason to suppose that nature is becoming more severe, the origin must be sought in changing human activities."

In many cases, the events that lead up to or constitute a natural disaster intertwine so subtly that the ultimate effect of a given activity or action is hard to predict. Overpopulation in a particular watershed may foster deforestation, which in turn can cause floods that destroy crops and that bring on food shortages, hunger, and political instability. In another similar watershed, overpopulation may lead to soil erosion, the silting of a hydroelectric reservoir, and power shortages in a city downstream.

Nature does not always work alone to create disasters. Human activities can set in motion chains of events that only seem natural. Industrial expansion and overplowing can, for example, serve to increase the amount of dust in the upper atmosphere. As a result, rainfall patterns change and food production falls. Eventually, the international balance of payments and political relations among countries are affected. In short, the casual relationships between human and natural activities are open-ended, and new stresses on the earth's ecosystem pose complex economic and social issues.

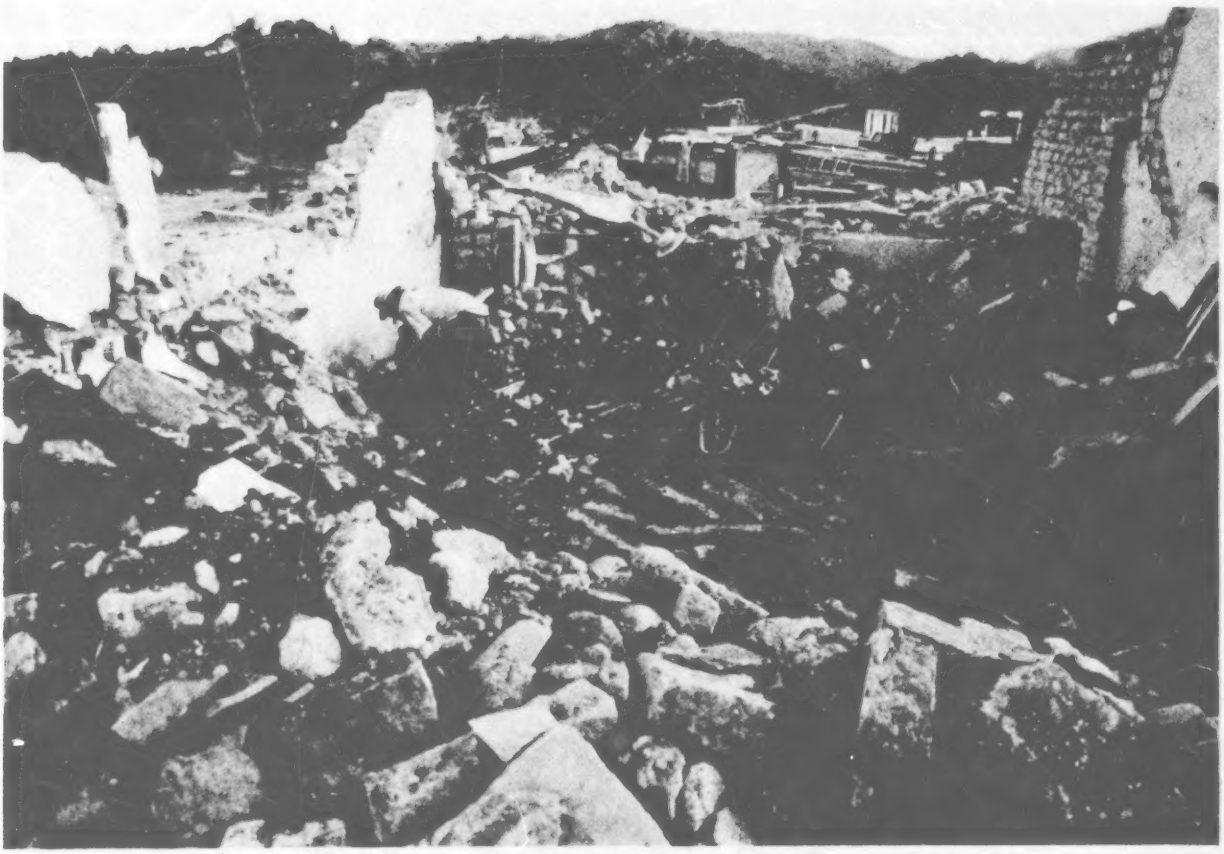
[1]This selection is reprinted from *The Twenty-Ninth Day*, 1978, pp. 64-67, by permission from Norton Publishing Co.

Reading 14

Earthquake Hazards In The Mountains

by Kenneth Hewitt

. . . When undisturbed, all but the steepest valley sides support a fairly dense forest cover up to 13,000 feet. It is dominated mostly by the deodar, the Himalayan cedar. Where the forest remains, there was far less damage than elsewhere; in particular, there were few rockfalls. But much of the forest has been cleared and most of what remains is overused. The incessant search for firewood, *the* energy source for cooking and keeping warm, has overreached the supply even here, although not to as extreme a degree as farther out in the foothills. The ever present herds of goats have also taken their toll through overgrazing and destruction of young trees.



The Aftermath Of An Earthquake

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So most farms and villages are surrounded by deforested slopes. Many are terraced, of course, and may rise more than 2,000 feet without a break. In the winter, bare soil and loose rock — unstable debris easily set in downslope motion by the earthquake — are conspicuous around and above settlements.

The immediate cause of damage during the earthquake were about equally divided between the effects of the ground motion itself and the impact of rockfalls and landslides set off by the earth tremors. Ground motion caused the shaking apart of structures and, especially on steeper slopes, the breakup and slumping of the ground itself. Disintegrating retaining walls or downslope slumping of the soil body damaged many terrace walls; the collapse of buildings was also due, in perhaps half the cases, to ground motion or failure.

But everything depended upon location and local terrain. Larger settlements, such as Pattan, are on broad river terraces or alluvial fans where the valleys widen. Here ground motion was decisive in the amount of damage. Apart from being less exposed to landslides from steep slopes, these areas have deeper alluvial subsoils where ground movement is generally more severe in earthquakes.

Conversely, farms and villages in the steep-walled tributary valleys and narrows of the Indus suffered mainly from the terrible rain of boulders following the tremors. The results were more like bomb damage. Landslides were also a large factor in the destruction of irrigation channels and terraces here. Moreover, landslides are a particularly bad way for terracing to go. The entire soil element is swept away, sometimes directly into a stream bed and downstream before it can be recovered. Here, it probably ended up in Tarbela Dam, a huge irrigation and power project some 75 miles down the Indus. Since sedimentation is a major problem in the economic lifetime of the reservoir, agricultural productivity was thus diminished at both ends.

The special and most terrifying feature of an earthquake is that, more than any other natural hazard, it attacks our shelters and man-made structures. Nearly all types of buildings in Indus Kohistan fared badly in the disaster — modern *pukka* buildings of dressed stone and mortar or concrete, as well as traditional *kutcha* work in mixtures of mud, wattle, timber, and boulders.

A few old and traditional buildings did as well as any modern structures. If their walls and roofs were made of sound timber, wood-frame houses of traditional design fared best of all. Studies elsewhere have shown that small timber-frame buildings do well in earthquakes. But when individual walls and building blocks can move independently or when the material is rigid and brittle, buildings readily shake apart. . . .

In terms of social and economic disruption, however, damage to terraces and irrigation systems may be more critical than that to buildings and second only to human casualties in its significance. The terraces are the main economic base for the majority of the population. A few groups specializing in herding own most of the livestock, a useful source of income, clothing, and to some extent, food; but irrigation agriculture, with maize the main crop, is much more critical. . . .

For the world as a whole, an average year in the mid-twentieth century brings some thirty-two major natural disasters. Of these, four are earthquake triggered, accounting for some 14,000 fatalities. High mountain regions are areas of concentrated seismic risk, notably in the western cordilleras of the Americas, the Eurasian and African mountain chains from Morocco to western China, and the mountainous islands of Southeast Asia. While nearly 70 percent of potentially damaging earthquakes take place in the circum-Pacific belt, only 20 percent of the mid-century (1949-69) casualties were reported here. But the Himalayan-Mediterranean zone, from Burma to Morocco, with only 14 percent of dangerous earthquakes, accounted for nearly 75 percent of the casualties. Clearly, there is a relation between the relative density of human occupancy and earthquake risk.

There are strong indications that the number of natural disasters and the degree of damage in general have increased in this century. Since there is no reason to suppose that nature is becoming more severe, the origin must be sought in changing human activities. In wealthy nations, the level of economic losses is increasing; in poorer countries, both mortality and economic loss are expanding. The disaster in Pakistan serves as an example of the extent of the problem, while at the same time offering a case study in possible strategies for rehabilitation.

First, the scale and frequency of such disasters in high mountains is not merely a result of seismic conditions but rather the worst expression of recent socio-economic pressures and environmental deterioration. Rapid deforestation, overgrazing, and the extension of cropping to ever more marginal areas, all of which accelerate erosion, flooding, and silting of bottomlands, are spreading rapidly throughout the world's tropical and subtropical high mountains. One of the effects of this convergence of environmental damage and socio-economic stresses is to greatly enhance the risk from pests, disease, landslides, floods, and earthquakes.

In many regions, the processes of environmental damage are far more advanced than in Indus Kohistan, but it would be erroneous to imagine that this is anything but a matter of time. Between visits in 1962 and 1975 to the Himalayan tracts of Pakistan closer to the plains, I found a staggering increase in forest damage, bar slopes, gullying, and landslides. The potential damage from an earthquake there is very great indeed, not least in the enormous pulse of sediment it would hurry into rivers, dams, and irrigation works so vital to Pakistan's survival. . . .

Let us examine, for example, a strategy for rehabilitating the Indus Kohistan area that would take full account of the local habitat and economy. Remember, damage to the habitat has not yet gone so far that it could not be restored in a small number of years. The people are sturdily independent, hardworking, and not yet ready for the climactic abandonment of old ways and land that is happening elsewhere. And unless one compares it with the rich agriculture of the Punjab

plains the area appears productive and could be more so with improved labor-intensive cultivation. . . .

Afforestation, since it offers benefits in all areas, from environmental protection to resources for improving building quality, should be at the core of any rehabilitation program. But it must be a mixed strategy, not lines of trees marching up and down every mountain. Afforestation must include pure stands of timber on vulnerable watersheds, with shelter belts and avenues along roads and paths. There must be farm forestry with, say, fruit and nut trees carefully selected and planted to improve terrace stability and provide additional income without interfering with grain cultivation; trees whose leaves will provide fodder, but also areas from which grazing must be excluded; commercial lumber stands for eventual export and avenues of quick-growing trees in villages and on farms to provide for local constructional timber.

Dilemma 7 — COURTING DISASTER

As earthquakes go, the earthquake that shook Atar on the morning of January 12 was a moderate one, registering only 4.9 on the Richter scale. But the damage to people and land was more devastating than any other recorded earthquake. Entire villages came crashing down the terraced mountainsides. Rockfalls and landslides killed thousands of people and many thousands more cattle, goats and buffalo. Farms were destroyed. Buildings were crushed, and the major road into the area was blocked.

The earthquake had other far reaching effects. Irrigation systems that watered the valley outside the direct earthquake zone were damaged. Soils were carried into the dam that provided electric power and water. The increased soil sediment into the lake behind the dam would lead to more rapid aging of the lake and threaten future water supplies.

How a mild earthquake could wrought such damaging tolls on human lives and property was readily explained by the experts who came to survey the disaster. With a very large and poor population, nearly every acre of land in steep, mountainous Atar was used to its limits. Dense forests had long been stripped for building materials and firewood for cooking and heating. The mountainside had been cut one tier after another for small marginal farm plots. The combination of treeless mountains, weak retaining walls of the terraced farms, and loose rock and soil had set the stage for massive landslides when the earth trembled.

Soon after the earthquake, the stoic and hardy peasants soon began the process of rebuilding their mountainside villages and planting crops on the slopes. However, they were again creating the same conditions that made them so vulnerable to the earthquake damage.

Pintot, a peasant, when asked why he was returning simply shrugged and said, "I have no other land and I must feed myself and my family. This was the first earthquake in a hundred years so we wouldn't be around for the next one".

Yet, as the mountain repopulates, the remaining forests will further diminish and erosion will increase. One solution to the problem is to keep the people from living and farming the area. Should the government take action to stop the people from returning? Why or why not?

DISCUSSION QUESTIONS

- Does government have the right to dictate what people do on their own land? Why or why not?
- What responsibilities should government have toward the safety of its people? Why?
- Since earthquakes are a natural occurrence, is it possible to really protect people from the effects?
- If good farmlands are so scarce in the country, is there anything that the government can do?
- The activity of the farmers who live in the mountains may be creating dangers not only to themselves but to the people living below. What responsibilities do they have to other people?
- Should the farmers think about how their activities might affect the environment in the future? Why or why not?
- Why do you suppose that people continue to do things even when they know the dangers?
- If scientists discover how to better predict earthquakes, will warning people about an earthquake solve the problem? Why or why not? How might people be affected if they know about the next earthquake in advance?

Activity 7: Directions For The Future

In this module you have examined some of the effects and consequences of human activities on the resources of Earth. Possibly you have considered some alternative ways in which people can use land and resources with greater care. If you were able to influence the way human society conducts its activities, what directives might you issue?

As a final activity, write a short essay describing ways that society should more wisely act in order to better protect our environment from harm as well as to provide adequately for everyone now and in the future. Assume that you are writing from the viewpoint of a leader in the future, issuing a code of behavior/ conduct that you wish people to follow. You may wish to cover several topics or develop a single topic in greater depth and detail. In either case the important objective is to offer practical solutions that are attractive and desirable to the people of the society. It may be necessary to explain the benefits that can be achieved when people make certain changes in their present way of living.

In developing your essay consider the following questions or concerns.

- What aspects of the environment do you like? Dislike? What changes do you want to see?
- What types of activities might create the greatest potential harm to people and the earth?
- Will your code be fair to everyone?
- What are society's most important needs and how can they best be met?
- Is it possible to have all our modern conveniences and products of technology and still maintain a high quality environment?
- What human activities need to be changed? Will such changes be difficult to accomplish?

Some possible topics might include:

- **Use of wilderness lands**
- **Urban development**
- **Suburban development**
- **Housing**
- **Energy sources**
- **Pollution**
- **Food production**
- **New technologies**